THE UTILITY OF KNOWLEDGE MAPPING AS AN APPROACH TO IMPROVING CORPORATE AND PROJECT PERFORMANCE: A CASE STUDY OF A LARGE SOUTH KOREAN CONSULTING FIRM

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The author declares that this thesis was the result of his own work. No portion of the work covered in the thesis has been submitted in support of another application for another degree or qualification at this or any other university or other institute of learning.

Abbreviations

HRD	Human resource development
HRM	Human resource management
IBT	Internet-based technologies
ICT	Information and communication technologies
IT	Information technologies
KM	Knowledge management
KMS	Knowledge management system
MBT	Mobile-based technologies
PDA	Personal digital assistant
PMIS	Project management information system
Q&A System	Question and answer system
RFID	Radio frequency identification
SNW	Social networks
Wibro	Wireless broadband internet

Abstract

Knowledge, and its appropriate management, has been increasingly recognised as a critical source of sustainable competitive advantage for companies. Within this context, many companies are developing their strategies and capabilities to effectively create, share and exploit knowledge. This issue has been seen to be particularly important in project-based industries, such as the construction industry.

However, in spite of the espoused value of knowledge management approaches they often deliver benefits far below expectations. Research and practice has identified a number of problems and barriers which have depleted the actual benefits of knowledge management in projects and companies. A generic finding is that the major problem is the lack of effective integration of key knowledge management components. Knowledge maps have been promoted as a key solution to bring about this required integrated approach. The knowledge mapping approach has taken root in other sectors (particularly education and manufacturing), but is still at an embryonic state in construction. The starting point for this research is to investigate the potential utility of knowledge mapping as an approach to improving corporate and project performance. First, a concept model for appropriate knowledge mapping within construction project organisations was articulated through a relevant literature review. The model is made up of four key variables: interaction environment, construction actors, construction processes and knowledge transfer technologies. The concept model was tested through a single-holistic case study within a large construction and property consulting practice in South Korea. Data collection was through semi-structured interviews and company document review. The primary data was analysed using content analysis and cognitive mapping.

The research findings broadly confirmed that knowledge mapping is an effective approach in integrating project resources and technologies for successful knowledge management within the case study firm. The key characteristics of the concept model in practice are identified and illustrated. A contingency approach to knowledge mapping is proposed with appropriate approaches dependent upon the scope of the construction processes and the scope of the construction actors.

Chapter 1 Introduction

1.1 Introduction

This chapter introduces the overall focus of this research. The chapter is organised as follows:

(1) the background for this study is set out;
(2) the research problem is articulated;
(3) a summary of the methodology is given;
(4) a synopsis of the thesis is laid out; and,
(5) finally, a summary of the chapter is provided with a link to Chapter 2.

1.2 Background to the research

Knowledge, and its appropriate management, has been increasingly recognised as a key strategic resource for successful project-based companies and for individual projects and a critical resource of sustainable competitive advantage (Armistead, 1999, Desouza and Evaristo, 2003, Astrid and Peter, 2005, Halawi *et al.*, 2006).

Indeed, it is argued that knowledge has become the core resource of the modern economy for companies, rather than the traditional resources of money, land and materials (Bell, 1973, Drucker, 1992, Drucker, 1993, Nonaka and Takeuchi, 1995). This shift in the importance of knowledge has been captured by many academics and practitioners in the term "knowledge economy" (Hoffman *et al.*, 2005, Halawi *et al.*, 2006, Meroño-Cerdan *et al.*, 2007).

Within this perspective, many companies are increasingly interested in the potential benefits of knowledge management and developing their strategies and capabilities to effectively create, codify, share and use knowledge in a purposeful fashion (Hansen *et al.*, 1999, Nonaka *et al.*, 2000, Bhatt, 2001, Maier, 2002). Davenport *et al*. (1996), Syed-Ikhsan and Rowland (2004) and Egbu *et al*. (2005), for example, have stressed that products and services in projects and businesses can be more successfully delivered with appropriate knowledge management

approaches which provide project members the right knowledge and knowledge owners at the right time.

This issue is seen as being particularly important in project-based industries, such as the construction industry, where the effective management of project-based knowledge can lead to improve project performance. Project-based knowledge is embedded within project components and resources and its effective management can provide the specific capabilities and competencies for improved project performance and, as a consequence, successful delivery of products or services to customers (Eldin, 1999, Poell and Van-der-Krogt, 2003, Law and Chuah, 2004, Maqsood *et al.*, 2006).

In the construction industry, projects are delivered by temporary project teams or organisations made up different functional groupings, such as design actors and construction action (Levy, 2000, Walker, 2002, Cooke and Williams, 2004, Loosemore *et al.*, 2006). This means that the specific project-based knowledge and skills are owned and used by each individual organisation. The critical challenge in temporary project organisations is to successfully transfer specific project-based knowledge to other parts of temporary project organisation. When this transfer does occur successfully, the capacity and skills of the constituent individual construction actors is enhanced (Santos and Powell, 2001, Love *et al.*, 2004, Maqsood *et al.*, 2006, Raidén and Dainty, 2006).

In summary, knowledge and its effective management is recognised as a key strategic resource and capability to enable construction project organisations to capture and transfer project-based knowledge, to build their knowledge assets (Robinson *et al.*, 2001, Kamara *et al.*, 2002, Kazi, 2005, Egbu, 2006).

This section has set out the broad background for the research topic. The next section presents the research problem.

1.3 Research problem

The potential benefits of knowledge management have been championed by a number of researchers, as a key capability which can generate sustainable competitive advantage (McCampbell *et al.*, 1999, Soliman and Spooner, 2000, Hoffman *et al.*, 2005, Meroño-Cerdan *et al.*, 2007).

However, in spite of the claimed value of knowledge management, a number of problems and barriers have been identified in practice, which erode the actual benefits of knowledge management in projects and companies. The problems include: knowledge and knowledge management strategy-based problems (Zack, 1999, Desouza and Evaristo, 2003, Smith, 2004, Meroño-Cerdan *et al.*, 2007); human resource-based problems (Egbu, 2001, Thite, 2004, Chua and Lam, 2005, Stuckenschmidt *et al.*, 2005); knowledge management technology-based problems (Koch, 2003, Hustad, 2004, Bennet and Tomblin, 2006, Foos *et al.*, 2006); and, process-based problems (Davenport *et al.*, 1996, Maier and Remus, 2002, Kang *et al.*, 2003, Plumley, 2003). A number of key prescriptions have been offered to overcome these problems. The key research problems are discussed as follows.

First, knowledge and knowledge management strategy has been recognised as a vital success factor (Smith, 2004, Astrid and Peter, 2005, Chua and Lam, 2005, Gammelgaard and Ritter, 2005). Hansen *et al*. (1999), for example, have argued that there are two principal knowledge management strategies: codification and personalisation.

Second, a number of technologies have been offered to effectively and successfully manage knowledge in projects and companies (Minsky, 1975, O'leary, 1998, Gomez *et al.*, 2000, Rollet, 2003). However, it has been argued that the technologies have not been effectively considered or applied for knowledge management and its successful development (Kreiner, 2002, Rollet, 2003, Hellström and Husted, 2004, Bennet and Tomblin, 2006). The importance of technologies for effective knowledge transfer has been advocated, but it is

increasingly recognised that item is a lack of theories and techniques, such as knowledge visualisation tools, knowledge transfer systems and knowledge search systems (Fernandes and Raja, 2002, Albino *et al.*, 2004, Malik, 2004, Sun and Scott, 2005).

Third, it has been stressed that human resources are a key variable in successful knowledge management, because people make the key decisions for knowledge management in projects and companies (Dougherty, 1999, Scarbrough, 2003, Thite, 2004, Bennet and Tomblin, 2006). Within this context, empirical studies have demonstrated that staff are the key knowledge owners and users (Li and Gao, 2003, Scarbrough, 2003, Thite, 2004, Stuckenschmidt *et al.*, 2005). Nevertheless, majority of knowledge management studies adopt a technology-centred approachm rather than a human-centred one. Bhatt (2001), Kautz and Thaysen (2001) and Robinson *et al*. (2005), for example, emphasised that the interactions between technologies and people are critical for successful knowledge management.

Finally, Mier and Remus (2002) argued that project processes must be used as a critical component for successful knowledge management because projects are commonly delivered through various numbers of phases and sub-processes. Furthermore, projects are always completed by the construction actors, performing the processes and sub-processes (Peurifoy *et al.*, 1996, Levy, 2000, Mcgeorge and Palmer, 2002). Liu and Hsu (2004), for example, stressed that all of the projects in turn have different processes and sub-processes which are always performed by different people, using their own different project resources, project-based knowledge and technologies. This presents a particular challenge for temporary project teams. In addition, Kim (2003) and Kang (2003) have been insisted that project processes must be used as a vital project-based knowledge management factor for successful process-based projects. Nevertheless, project processes have not been fully integrated into knowledge management systems, even in process-based projects and industries (Kang *et al.*, 2003, Kim *et al.*, 2003,

Plumley, 2003, Liu and Hsu, 2004).

It has been established that there are individual barriers – inadequate strategies, technologies, and so on – to successfully knowledge management. The system barrier, however, is the lack of effective integration of key project resources and technologies. The argument here is that the key project resources and technologies must be treated as the vital variables for appropriate knowledge mapping in projects and companies (Dougherty, 1999, Anon, 2003, Astrid and Peter, 2005).

Nevertheless, the importance and need of integrating the project resources and technologies do not appear strongly in the majority of the literature or in practice. Within this context, knowledge mapping has been promoted as a key solution for effectively integrating the key project components and technologies in projects and companies (Grey, 1999, Gomez *et al.*, 2000, Wang, 2002, Plumley, 2003).

There is a dearth of empirical studies which have investigated the utility of knowledge mapping within a construction context (Egbu, 2004). Robinson (2005), for example, stressed that people and project processes must be integrated for successful knowledge management in projects and organisations. In addition, Kamara (2002) and Maqsood (2006) emphasised that construction workers, project processes and technologies must be considered and integrated for successful knowledge management within projects and organisations.

1.4 Research objectives and articulated research questions and hypotheses

The aim of this study is to investigate the utility of knowledge mapping as an approach in order to effectively improve corporate and project performance through project-based knowledge transfer between construction actors and their teams within and across construction project organisations. This was pursued through a number of research questions. The research questions and hypotheses

are as follows.

■ Research questions

Q1. Is knowledge management an appropriate aspiration for effective project performance and project-based learning in projects and organisations?

Q11. Is knowledge mapping an appropriate tool to improve performance and enhance learning within and across construction project organisations?

Q2. In construction project organisations, how can an appropriate knowledge map be developed for effective project performance and learning?

Q21. What types of construction project components and knowledge transfer technologies should be part of an effective knowledge mapping approach?

Q22. How should the knowledge map components be integrated?

■ Research hypotheses

Meta-hypothesis:

Knowledge mapping is more likely to promote effective project performance and learning within temporary construction project organisations when the construction actors, construction processes and knowledge transfer technologies are effectively integrated - compared to knowledge maps developed without the appropriate development and integration of construction actors, construction processes and knowledge transfer technologies.

Project-based resources

Hypothesis 1-1: Construction actors

Knowledge mapping is more likely to be successful when construction actors who are critical and necessary to successfully perform construction projects are effectively integrated into the knowledge mapping approach.

Hypothesis 1-2: Knowledge transfer technologies

Knowledge mapping is more likely to be successful when the knowledge transfer technologies integrated as a key knowledge mapping component.

Hypothesis 1-3: Construction processes

Knowledge mapping is more likely to be successful when construction processes are integrated into the knowledge mapping approach.

■ *The interaction between the knowledge map model components*

Hypothesis 2-1: Construction actors and knowledge transfer technologies

Knowledge mapping which integrates construction actors and knowledge transfer technologies will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

Hypothesis 2-2: Construction processes and construction actors

Knowledge mapping which integrates construction processes and construction actors will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

Hypothesis 2-3: Knowledge transfer technologies and construction processes

Knowledge mapping which integrates knowledge transfer technologies and construction processes will improve project performance and learning within

temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

1.5 Research methodology

An interpretative research philosophy is adopted for this study. A single case study approach which is aligned with the interpretative research philosophy is selected as an appropriate research access strategy. Research data collection techniques involved literature review and synthesis, semi-structure interviews and company document review are adopted to collect, analyse and apply the research data in the case study. The content analysis and cognitive mapping techniques are employed as the key data analysis tools in this study.

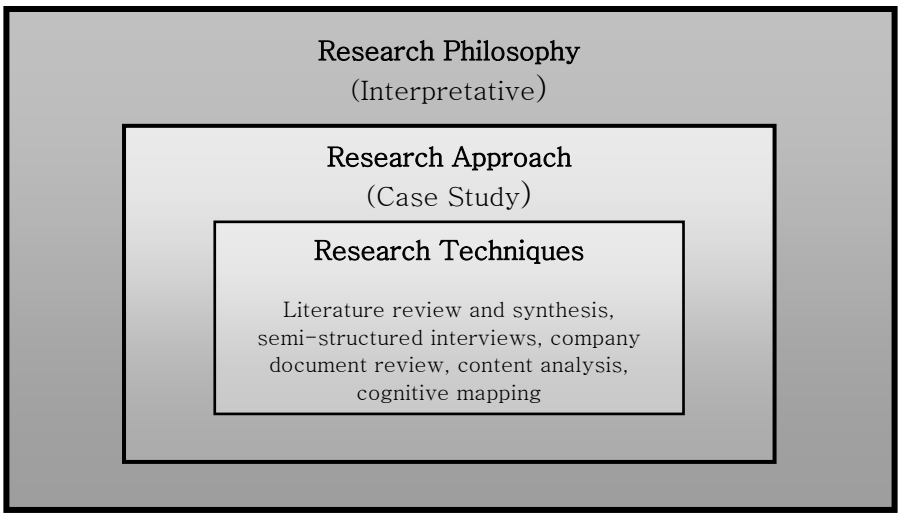


Figure 1.1 The nested research methodology approach

[Source: Adapted from Kagioglou *et al*. (1998)]

1.6 Synopsis of the thesis

This thesis is structured into seven chapters. Each chapter is summarised below.

Chapter 1: Introduction

Chapter 1 introduces the research background and the research problem for this

study. Then, a summary of the research methodology and a synopsis of the thesis are presented.

Chapter 2: Literature review and synthesis

Chapter 2 presents a literature review and synthesis which is used to develop the research questions and the concept model. First, the characteristics of construction organisations and knowledge maps are reviewed. Then, an appropriate knowledge map in construction organisations is conceptualised. Next, the research questions are presented. The focus of an appropriate knowledge map model in construction organisations is discussed based on the selection of key project components and knowledge transfer technologies.

Chapter 3: Knowledge map concept model and hypotheses

Chapter 3 presents a knowledge map concept model for this study. Within the concept model, the key components are described and the gap analysis questions are articulated. Then, the research hypotheses are formulated based on the concept model and gap analysis questions.

Chapter 4: Research methodology

Chapter 4 presents and justifies the research methodology adopted and used for this study. Within the research methodology, selected research philosophy, approach and techniques are presented. Finally, the validation aspects of this study are discussed.

Chapter 5: Research findings and testing of research hypotheses

This chapter presents the key research findings and testing research hypotheses within the context of the case study.

Chapter 6: Conclusions

Final, Chapter 6 summaries key findings. Recommendations for successful knowledge mapping in construction organisations are mentioned and limitations

of the research are stated.

1.7 Summary and link

This section was set out as the outset of this study and described the background of the research, research problem and outlined research methodology. The next chapter set out the literature review and synthesis.

Chapter 2 Literature Review and Synthesis

2.1 Introduction

This chapter reviews the relevant literature to develop and substantiate the research questions proposed in Chapter 1. This chapter is structured as follows:

(1) the key characteristics of construction project organisations are investigated;
(2) the specific principles and features of knowledge mapping are explored;
(3) an appropriate knowledge mapping approach within construction project organisations is discussed and represented; and,
(4) a summary of this chapter is provided with a link to Chapter 3.

2.2 Key Key characteristics of construction project organisations

2.2.1 Introduction

The construction industry has been argued to be a project-based industry, where different construction companies form temporary project organisations to develop, plan, perform and deliver projects (Bresnen, 1990, Dubois and Gadde, 2002, Loosemore *et al.*, 2006, Raidén and Dainty, 2006).

In the next subsections, Tthe project-based nature of construction projects and unique characteristics of project organisations are explored in the following sub-sections through a number of perspectives: knowledge-based view; learning organisation-based view; human resource-based view; project process-based view; and, knowledge transfer technology-based view.

2.2.2 Knowledge-based view

Drucker (1993) defined knowledge as meaningful intellectual property, rather than capital or labour, and that knowledge was as the only competitive and economic resource in the knowledge society. In the knowledge management area, a number of academics and practitioners argued that knowledge must be managed

in order to effectively implement and successfully complete projects in companies (Maier, 2002, White, 2002, Scarbrough, 2003, Halawi *et al.*, 2006). Rollet (2003) and Heng (2001), for example, emphasised the value of knowledge as an intellectual capital because knowledge can be (should be)has been recognized as a real asset of enterprise as it is successfully identified, captured, codified, classified, transferred and used by its users within projects and organisations. From this perspective, a variety of knowledge types have been articulated, for example: explicit (tangible) knowledge and tacit (intangible) knowledge; individual knowledge and organisational knowledge; and, external knowledge and internal knowledge.

First, knowledge can be conceptualised as tacit knowledge and explicit knowledge. Takeuchi (1995) and Li and Gao (2003), for example, distinguished between tacit and explicit knowledge. According to Takeuchi (1995), tacit knowledge is difficult to codify, classify and transfer and is usually in the domain of subjective, cognitive and experiential learning, whereas explicit knowledge can be effectively codified, classified and transferred between people within and across organisations and furthermore, explicit knowledge deals with more objective, rational, and technical knowledge like data, policies, procedures, documents.

Second, it has been argued that knowledge must be classified into individual knowledge and organisational knowledge in order to effectively transfer and use within and across projects and organisations. Within this perspective, individual knowledge is vital for developing organisational knowledge, but organisational knowledge is not simple the sum of individual knowledge bases (O'leary, 1998, Bhatt, 2002, Li and Gao, 2003). Furthermore, it has been emphasised that organisational knowledge is an organised combination of data assimilated with a set of regulations, laws and procedures learnt through experiences and practice and also, organisational knowledge is formed by specific and unique patterns of interactions and relationships between people, technologies, techniques and contexts, which can be not easily imitated or made by the other organisations

(Bhatt, 2001).

Finally, a number of academics and practitioners have suggested a variety of classification and codification approach, including: process-based knowledge (Maier and Remus, 2002, Maier and Remus, 2003); workflow-based knowledge (Kang *et al.*, 2003); human resource-based knowledge (Thite, 2004, Astrid and Peter, 2005, Foos *et al.*, 2006); and, project-based knowledge (Poell and Van-der-Krogt, 2003, Leseure and Brookes, 2004, Liu and Hsu, 2004).

From these perspectives, a variety knowledge management processes have been stressed in order to effectively manage knowledge, such as knowledge creation process, knowledge conversion process, knowledge transfer process, knowledge use process and knowledge store process (Maier, 2002, Tiwana, 2002, Rollet, 2003, Robinson *et al.*, 2005). Nonaka and Takeuchi (1995), for example, proposed a knowledge creating model which is composed of four key variables: socialisation; externalisation; internalisation; and, combination because it needs to understand the dynamic nature of knowledge creation and to effectively manage such as process. Figure 2.1 is the spiral of knowledge creation.

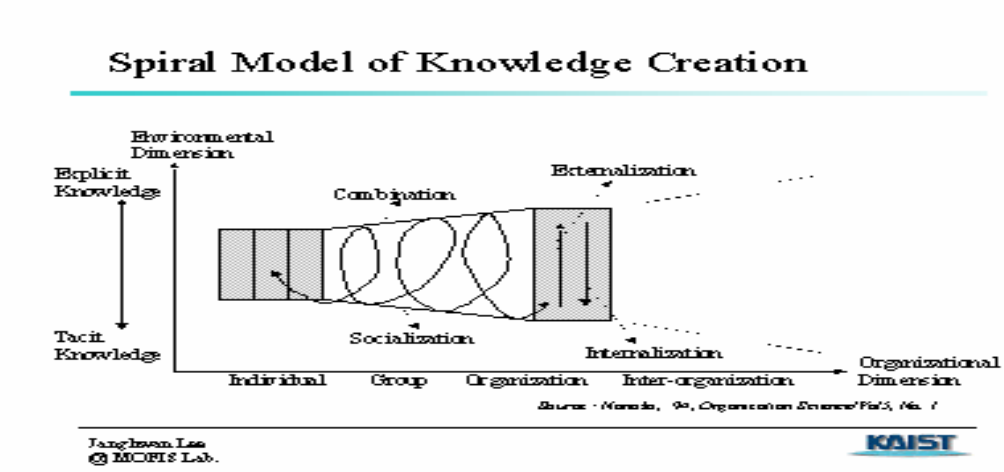


Figure 2.1 Spiral of organisational knowledge creation

[Source: Nonaka and Takeuchi (1995)]

As can be seen in Figure 2.1, knowledge is created and converted in the dynamic and complex contexts. Construction project has been also argued and recognised as a dynamic and complicated project-based context where project-based knowledge is created, used, stored and transferred by construction actors within construction project organisations (Kamara *et al.*, 2002, Hari *et al.*, 2005, Robinson *et al.*, 2005, Egbu, 2006). However, construction industry has recently focused on the fact that the efficient management of knowledge leads to the creation of competitiveness and value within construction project organisations, improving project performance through skills and knowledge of organisation members (Robinson *et al.*, 2001, Kazi, 2005, Robinson *et al.*, 2005, Maqsood *et al.*, 2006). Therefore, it can be said that construction project-based knowledge must be managed for effective project performance and successful project completion (Lu and Sexton, 2006).

2.2.3 Learning organisation-based view

Successful learning organisations facilitate learning and innovation of their all organisation members and continuously transform and nurture itself to generate sustainable competitive advantage (Garratt, 1987, Senge, 1990, Pedler, 1995, Garavan, 1997). From this perspective, it has been argued that learning organisations can more effectively respond and adapt to changing internal and external context (Jashapara, 2003, Dymock and McCarthy, 2006, Thomas and Allen, 2006). One of the critical issues of learning organisations is the ability and skills of staff to learn and use knowledge (McHugh *et al.*, 1995, Sambrook and Stewart, 2000, Kim *et al.*, 2003, Law and Chuah, 2004).

It has been emphasised that learning organisations are a project-based organisation in which projects are performed by skilled and functioned workers. As a result of, it has been suggested that construction organisations are a type of learning organisation (Santos and Powell, 2001, Love *et al.*, 2004, Maqsood *et al.*, 2006, Raidén and Dainty, 2006).

Project organisations are commonly divided into several specialised parts where construction actors are grouped (Levy, 2000, Walker, 2002, Cooke and Williams, 2004, Loosemore *et al.*, 2006). Maqsood *et al*. (2006) argue that a construction project organisation which, as a learning organisation, comes together with its construction workers and professionals to successfully accomplish the construction project has its own capacity and knowledge in a form of people, processes and technologies. In the construction project-based environment, Love (2004), for example, proposed a blueprint for a successful learning organisation which considers the relationships and interactions between total quality management and customer value strategies.

In summary, construction organisations are structured around project and project teams. This means that the success of construction projects is dependent upon the ability of project members.

2.2.4 Construction actor-based view

All construction project organisations tend to be different in that they produce different buildings, but organisations share similar fundamental resources, such as actors, materials, processes, methods, equipments and sites (Cooke and Williams, 2004). From this perspective, it has been stressed that construction actors are a critical resource for successful projects because they are concerned with the use and management of the resources to effectively perform their roles within construction project organisations (Hore *et al.*, 1997).

As has been connected in the previous section, the construction industry is project-based, and that project team members are perceived to be a valuable asset and resource for successful construction projects (Morton and Jaggar, 1995, Harrison, 1996, Shirazi *et al.*, 1996, Wong *et al.*, 2006).

In the context of human resource management and development (HRM and HRD),

a number of practitioners and researchers have argued that construction actors have and use their own specific knowledge and basic abilities, such as know-how, insights, skills, experiences and qualifications and often share and transfer to the others within/across construction project organisations (Harrison, 1996, Shirazi *et al.*, 1996, Griffith and Watson, 2004, Loosemore *et al.*, 2006). Therefore, it can be seen that construction project organisations are a vehicle for combining the knowledge and ability of construction actors toward successful project performance. However, it has been argued that combining the specific knowledge of construction actors is difficult because a various number of construction actors (such as designers, quantity surveyors, inspectors, project managers, contractors) have their own specific and different knowledge, skills and language in the different construction parts, such as construction part, management system part, design part, structural engineering part and quantity surveying part (Bresnen, 1990, Morton and Jaggar, 1995, Gidado, 1996, Loosemore *et al.*, 2006).

In order to successfully accomplish construction projects, it has been argued that organisational structure must be necessarily used to appropriately engage and deploy construction actors in the each construction project organisation (Walker, 2002, Maqsood *et al.*, 2006). Johes *et al*. (1998), for example, stressed that organisational structure is the systematic and formal system of task and management reporting relationships that coordinates and motivates organisational members so that they work together to achieve organisational design goals. In addition, Anumba *at el*. (2002) noted that organisational structures are classified by grouping of roles, tasks and functions. Therefore, it can be said that building an appropriate organisational structure needs to effectively transfer knowledge between construction actors and their organisations for project performance and successful project completion within construction project organisations.

In order to successfully complete construction project, a lot of construction actors are engaged and the challenge is to effectively transfer project-based knowledge between the construction actors. Shirazi *et al*. (1996) and Griffith and Waston

(2004), for example, note that construction project organisations must have effective communication between construction actors and their organisations to successfully perform construction projects because poor communication can be a key obstacle to transfer project-based knowledge. From this perspective, Bresnen (1990) and Fryer (2004), for example, notice that having good communication between actors enable the transfer and use of knowledge.

In brief, construction actors have different abilities, specific knowledge bases and professional languages. In this regard, knowledge transfer has been emphasised as a critical method for effective project performance (Kautz and Thaysen, 2001, Fernandes and Raja, 2002, Sun and Scott, 2005, Foos *et al.*, 2006). However, it has been noted that poor communication between actors is a critical barrier to effectively transfer project-based knowledge (Senge, 1990, Rowley, 1999, Daghfous, 2004, Gorelick, 2005).

2.2.5 Construction process-based view

Processes can be defined as a designed sequence of operations, possibly taking up time, space, expertise and other resource, which produces some outcomes (Feynman et al., 1963, Lindsay et al., 2003). This sequence has been seen as a value chain or supply chain where each step adds value to the proceeding steps (Czuchry and Yasin, 2003). It has been agreed that projects consist of several phases and many types of processes (Kamara *et al.*, 2000, Lindsay *et al.*, 2003, Plumley, 2003, Jugdev and Mathur, 2006). Projects which are commonly carried out and accomplished with performing phases and sub-processes can be improved by improving processes (Sarshar *et al.*, 2004, Tzortzopoulos *et al.*, 2005).

In the construction industry, it has been agued that construction is process-based (Kagioglou *et al.*, 1998, Kamara *et al.*, 2000, Levy, 2000, Sarshar *et al.*, 2004). According to Tzortzopoulos *et al*. (2005), different project process models have been developed by researchers and practitioners in order to improve effectiveness and efficiency of the design and construction activity due to the needs and

requirements for improving project performance. Within this regard, it has been argued that almost all the process models are a designed sequence of building, dealing with actors, materials, technologies, time, cost, quality and the other resources (Bresnen, 1990, Gidado, 1996, Chan *et al.*, 1999, Tzortzopoulos *et al.*, 2005).

Griffith and Watson (2004), for example, insiste that construction projects have a basic sequence: market demand or perceived needs; conceptual planning and feasibility study; design and engineering, procurement and construction; start-up for occupancy, operation and maintenance; and, disposal of facility (Walker, 2002, Koskela, 2003, Griffith and Watson, 2004). Furthermore, in order to effectively implement construction projects, several management systems, such as cost management, time management, risk management, value management and quality management, are used and applied, which basically have its sub-processes for its successful performance (Day, 1994, Mcgeorge and Palmer, 2002, Fisk, 2003, Griffith and Watson, 2004). According to Walker (2002), management systems provide construction actors a sense of project direction in projects.

In many cases, construction projects are divided into several major phases and many sub-processes for effective project performance.

Projects, however, often do not have any integrated or standardised process models because almost all the construction organisations have their own different or unique construction process models which have sometimes been developed according to project types (Levy, 2000, Fisk, 2003, Bouchlaghem *et al.*, 2004, Tzortzopoulos *et al.*, 2005). Therefore, it is argued that construction processes need to be integrated in the knowledge approach in order to effectively transfer project process-based knowledge.

2.2.6 Knowledge transfer technology-based view

Technology is critical supporter in product and service development (Skinner,

1982, Nystrom, 1990, Bye, 1995, Abecker *et al.*, 1998). Nystrom (1985), for example, agreed that technology is a key strategy factor in projects and organisations. Sexton and Barrett (2004) noted that the term "technology" is widely used as the machines, tools, procedures and systems, work routines used to transform material and information inputs: for example, people, capital, land and raw materials, into outputs: products and services. By Skinner (1982), technology has been defined as knowledge that is useful and necessary for product and service development, rather than as physical methods or techniques for producing products or services.

Within this broad context, technologies are argued to be necessary for effective knowledge management in projects and organisations. For effective project performance improvement and knowledge acquirement, it has been argued that knowledge transfer technologies are essential (Wright, 1993, Kautz and Thaysen, 2001, Turban *et al.*, 2002, Foos *et al.*, 2006).

In the construction industry, it is increasingly recognised that knowledge managements are essential technologies for effective project performance (Peurifoy *et al.*, 1996, Shirazi *et al.*, 1996, Walker, 2002, Fisk, 2003). Syed-lkhsan and Rowland (2004), for example, have noted that building knowledge transfer devices and systems is critical to sustainable competitive advantage and project performance. Furthermore, it has been argued that knowledge transfer technologies (like information and communication technology) can be effectively used for nurturing a learning organisation in construction (Love *et al.*, 2004, Robinson *et al.*, 2005, Raidén and Dainty, 2006). Within this context, many construction companies are now investigating how knowledge can be transferred within/across the individuals and organisations. In addition, it has been agreed that technologies are key components to transfer project-based knowledge one person to others and to convert tacit knowledge to explicit knowledge in the knowledge management environment (Bhatt, 2001, Liyanage and Poon, 2002, Sexton and Barrett, 2004).

In brief, a number of technologies are used to effectively transfer project-based knowledge. However, the major problem is that technologies for effective knowledge transfer in projects and organisations have not been fully sought or developed in the construction industry.

2.2.7 Summary and link

This section has presented the unique characteristics of construction project organisations. The following section discusses key characteristics of knowledge maps and their potential utility and application in the construction sector.

2.3 Knowledge maps

2.3.1 Introduction

Knowledge management has been recognised as an innovative process to improve supply chain processes and as a driving force to enhance competence and competitive advantage of enterprises through efficiently managing knowledge assets (Storey and Barnett, 2000, Kim *et al.*, 2003, Moffett *et al.*, 2003, Lu and Sexton, 2006).

However, it has been asserted that knowledge management is still at an immature phase and furthermore, its resultant benefits and advantages have not been clearly identified or substantiated (Long and Fahey, 2000, Caldwell, 2002, Sun and Scott, 2005, Meroño-Cerdan *et al.*, 2007). In the underdeveloped knowledge management area, knowledge maps have been proposed as a key fundamental resource for successful knowledge management (Grey, 1999, Eppler, 2001, Liu and Hsu, 2004, Henao-Cálad and Arango-Fonnegra, 2007).

2.3.2 Definition and potential benefits of knowledge maps

Knowledge management holds potential to identify, capture, codify, store,

disseminate, use, evaluate and update to leverage managing knowledge to maximise productivity and competitive advantage of enterprises (Rollet, 2003, Sun and Scott, 2005, Halawi *et al.*, 2006, Mohamed and J.Anumba, 2006) and to enhance exploitation, creation and use of intellectual assets of enterprise (Rowley, 1999, Marr *et al.*, 2002, Hellström and Husted, 2004, Hoffman *et al.*, 2005). However, it has been noted that knowledge management has many barriers and problems with respect to its development and operation, especially codifying and transferring knowledge and integrating and applying the key components of projects and businesses (Liu and Hsu, 2004, Driessen *et al.*, 2007).

In the knowledge management area, knowledge maps are defined as a critical process, method and tool to effectively visualise the sources, flows, constraints and terminations of tacit and explicit knowledge and also, knowledge mapping helps to understand the relationships between knowledge stores within projects and organisations (Grey, 1999, Speel *et al.*, 2000, White, 2002, Driessen *et al.*, 2007). White (2002) and Tiwana (2002), for example, argue that knowledge maps are used to develop conceptual maps as hierarchies or nets and support knowledge scripting and profiling and provide highly developed procedures to elicit and document conceptual maps from knowledge workers. Furthermore, it has been emphasised that knowledge maps are an interactive and open system for dialogue that defines, organises and builds on the intuitive, structured and procedural knowledge used to explore and solve problems (Wright, 1993). Kautz and Thaysen (2004) and Speel *et al.* (2000) for example, argue that knowledge maps are key prerequisite for effective knowledge management.

In summary, it has been agued that knowledge maps can be used as a means of visualising where knowledge is located and how the knowledge is related.

2.3.3 Characteristics of knowledge mapping: key purposes, principles and functions

Knowledge mapping has been championed as a useful way to support and help

capitalising knowledge for projects and organisations. The approach is a set of tools and processes which identify and visualise knowledge resources and knowledge flows in projects or organisations (Gomez *et al.*, 2000, White, 2002, Kang *et al.*, 2003, Plumley, 2003). Therefore, knowledge mapping must be explicitly based on the needs of project and business for successful knowledge management in companies. Table 2.1 organises the key purposes and principles of knowledge mapping proposed in the knowledge mapping area (Grey, 1999, Meso and Smith, 2000, White, 2002, Liu and Hsu, 2004).

Table 2.1 Key purposes and principles of knowledge mapping

[Source: Organised from Grey (1999), Meso and Smith (2000), White (2002), Liu and Hsu (2004)]

	Content
Key purposes of knowledge mapping	■ To generate knowledge and ideas. ■ To visualise complex structure (long text, hypermedia, large web sites). ■ To communicate complex knowledge and ideas. ■ To aid individual and organisational learning by explicitly integrating new and old knowledge. ■ To assess understanding or diagnose misunderstanding. ■ To easily access to relevant knowledge.
Key principles of knowledge mapping	■ Understand that knowledge is transient. ■ Explain the sanction, establish boundaries and respect personal disclosures. ■ Recognise and locate knowledge in a wide variety of forms; tacit and explicit, formal and informal, codified and personalised, internal and external and short life cycle and permanent. ■ Locate knowledge in processes, relationships, policies, people, documents, conversations, links, context, suppliers, competitors and customers. ■ Be aware of organisational level and aggregation, cultural issues and reward systems, timeliness, sharing and value, legal process and protection.

As detailed in Table 2.1, one of the key knowledge mapping objectives is to support and provide the specific people right knowledge and knowledge owners at the right time. However, it must be recognised that there are also a number of disadvantages and risks in projects and businesses in using knowledge maps. One obvious drawback in projects and organisations is related to possible damage caused by low-quality knowledge maps, for example in terms of time, misinterpretation of the context or simply the reliance on outdated or incorrect data and information (Eppler, 2001). Another disadvantage lies in the increased risk of involuntary spill-over of knowledge to competitors (Holsapple and Joshi,

1998). Above all, as has been mentioned in Section 2.2.1, it has been emphasised that knowledge maps can be effectively used to aid individual and organisational learning.

On the one hand, it has been argued that knowledge maps can help enterprises successfully build their knowledge management, project performance and project-based learning: technology-oriented knowledge management (Maier and Remus, 2003); decision supporting-based knowledge management (Klein and Cooper, 1982); web-based knowledge management (Wang, 2002); human resource-based knowledge management (Bish, 1999); project process-based knowledge management (Plumley, 2003, Liu and Hsu, 2004); and workflow-based knowledge management (Kang *et al.*, 2003). In addition, White (2002) proposed a number of key functions of knowledge maps: knowledge maps can be used to develop knowledge management; knowledge maps may support knowledge scripting and profiling, basic knowledge analysis; and knowledge maps may provide a solution against problems and troubles.

In this section, the key characteristics of knowledge map have been described. The next section presents the types of knowledge maps.

2.3.4 Types of knowledge map

Knowledge mapping is defined as a visual architecture of knowledge which enables and facilitates knowledge users more easily and quickly access to relevant knowledge and knowledge owners at the right time (Gomez *et al.*, 2000). Furthermore, knowledge maps can be modified and upgraded according to the need and change of the times and redeveloped by people who include knowledge users, knowledge map developers, knowledge possessors, knowledge innovators and knowledge managers in accordance with the need and change of industrial markets, sectors and the others (Wexler, 2001, Wang, 2002, White, 2002). There are a variety of types of knowledge map. The key types of knowledge map are discussed below.

First, procedural knowledge maps which are commonly called “process-based knowledge maps” are used to visualise knowledge and knowledge resources in the project or business processes in organisations (Kang *et al.*, 2003, Liu and Hsu, 2004). Process-based knowledge maps can be used for process-based projects, especially construction projects. These types of knowledge maps are more useful and effective for planning and implementing effective knowledge management.

Second, conceptual knowledge maps are for content management of knowledge which are used as a method of hierarchically organizing and classifying contents of knowledge (Caldwell, 2002). These types of map can be used for content management of knowledge, for example for web-based systems with taxonomy.

Third, competency knowledge maps which are employed to document the skills, techniques, positions, job experience and even career path of individuals, such as architects, engineering designers, quantity surveyors, project managers, construction managers, construction planners and construction operatives, to list and manage competency profile (Gorseline, 1996, Bish, 1999). Competency maps can be used for human resource management, human resource development and job placement and displacement. Furthermore, the knowledge maps can support knowledge users to find right knowledge owners and experts at the right time in projects and organisations.

Finally, other key knowledge maps that involve wed-based knowledge maps, strategy-based knowledge maps and cognitive knowledge maps have been proposed. In particular, social network knowledge maps which have been proposed as a type of principal knowledge map for effectively managing social networks in projects and organisations show the networks of knowledge and the patterns of relationships between organizations, its members and other social entities. A key purpose of social network knowledge maps is to analyse knowledge transferring and sharing in the social context (Plumley, 2003).

In summary, a various number of knowledge maps have been developed in accordance with their purpose and characteristics of the industrial sectors in which they are used.

2.3.5 Summary and link

In this section, the unique characteristics of knowledge map have been reviewed as a critical resource and component for successful knowledge management. The next section deals with finding an appropriate focus for successful knowledge map model development in construction project organisations.

2.4 Conceptualisation of knowledge mapping within construction project organisations

2.4.1 Knowledge and its effective transfer

Knowledge is a complex and multifaceted concept. Polanyi (1958) and Nonaka and Takeuchi (1995), for example, argued that knowledge can be classified into tacit knowledge and explicit knowledge.

In essence, explicit knowledge can be typically well-documented and visualised, while tacit knowledge is usually difficult to be codified and visualised. Gupta (2000), for example, argued that tacit knowledge is in the domain subjective, cognitive and experiential learning, whereas explicit knowledge is objective, rational and technical knowledge like data, policies, procedures, manuals, documents and lists.

On the one hand, according to Bhatt (2001), knowledge must be divided into individual knowledge and organisational knowledge for effective knowledge management. Within this perspective, Bhatt (2001, 2002), for example, agued that organisational knowledge is necessarily based on individual knowledge, but it is

not a simple sum of individual knowledge and also, organisational knowledge can be shaped through interactions between techniques, technologies and people, which can not be easily imitated and used by other organisations because the interactions are formed by their unique history and culture in organisations. Therefore, it can be said that knowledge must be mapped according to the differences of individual knowledge and organisational knowledge for successful knowledge management in projects and organisations, but it has been argued that it is in fact difficult to be classified and transferred (Nonaka and Takeuchi, 1995, Herschel *et al.*, 2001, Daghfous, 2004, Foos *et al.*, 2006).

In the construction industry, it has been argued that knowledge must be managed according to the nature, type and shape of knowledge (Robinson *et al.*, 2001, Kamara *et al.*, 2002, Egbu *et al.*, 2005, Pathirage *et al.*, 2007). For example, the term "project-based knowledge" has been used as a type of knowledge in the construction industry because construction is project-based. In this regard, it has been argued that project-based knowledge must be managed for construction projects and organisations (Kamara *et al.*, 2002, Egbu, 2004, Maqsood *et al.*, 2006). Furthermore, it has been argued that knowledge must be classified into tacit and explicit knowledge and individual and organisational knowledge according to its nature for effective knowledge management in the construction industry (Carrillo *et al.*, 2002, Kazi, 2005, Egbu, 2006). As has been mentioned in Section 2.2 and 2.3, construction project-based knowledge enables to improve project performance, to form core competencies and to continuously sustain competitive advantage of construction organisations.

Therefore, it can be argued that construction projects and construction actors' ability can be improved by effective construction project-based knowledge transfer in construction project organisations. However, the importance of project-based knowledge and its effective transfer in construction projects and organisations have been argued by a number of researchers (Sexton and Barrett, 2003, Egbu, 2006, Lu and Sexton, 2006, Maqsood *et al.*, 2006).

Arguing further, it has been emphasised that in order to gain its benefits with managing knowledge, systems and mechanisms for effective knowledge transfer are necessary (Shariq, 1999, Albino *et al.*, 2004, Hustad, 2004, Sun and Scott, 2005). According to Dougherty (1999) and Maier (2002), knowledge transfer is an increasingly popular phrase in the literature as practitioners attempt to stress importance of human resource in the knowledge management area. In the construction industry, it has been argued that knowledge transfer is a key process to effectively achieve project performance improvement on innovation (Wright, 1993, Koch, 2003, Sexton and Barrett, 2004, Egbu *et al.*, 2005).

Based on effectiveness and efficiency of knowledge transfer, technologies and systems have been argued as being key supporting tools in industries (Skinner, 1982, Abecker *et al.*, 1998, Fernandes and Raja, 2002, Foos *et al.*, 2006). In this regard, information and communication technologies (ICT) have been emphasised as key knowledge transfer technologies (Kautz and Thaysen, 2001, Koch, 2003, Hustad, 2004, Barber *et al.*, 2006), which is an umbrella term that includes any communication devices and applications, such as radios, televisions, telephones, mobile phones, computer and network hardware and software and satellite systems, as well as the various services and applications associated with information and communication technologies (ICT), such as video conferencing and distance learning. It has been argued that knowledge transfer technologies are critical tools to effectively enhance learning and to improve project performance (Santos and Powell, 2001, Love *et al.*, 2004, Maqsood *et al.*, 2006, Raidén and Dainty, 2006). Therefore, it can be said that technologies for effective knowledge transfer must be researched and developed to improve project performance through effective knowledge management.

2.4.2 Organisational networks within construction project organisations

Construction project organisations are organisationally divided into several

functioned departments for effective project performance. In each construction project organisation, it has been stressed that its organisational network is composed of all the departments required by the company in order to effectively produce its products or services (Jones *et al.*, 1998, Levy, 2000, Fryer, 2004, Jabnoun, 2005).

Anumba *et al*. (2002), for example, defined an organisational network as being a formal and structural system of task and management reporting relationships between actors and departments that coordinates and motivates organisation members so that they work together to achieve requirement of clients and objectives of projects. It has been agreed that structuring a organisational network is necessary for good communication between construction actors (Day, 1994, Morton and Jaggar, 1995, Griffith and Watson, 2004). Harrison (1996), for example, argued that organisational networks can be structured by grouping of roles, tasks and functions. Furthermore, it has been emphasised that organisational networks facilitate the transfer of project-based knowledge between construction actors and their organisations (Harrison, 1996, Shirazi *et al.*, 1996, Croucher and Druker, 2001, Loosemore *et al.*, 2006).

As a result of, it can be said that an effectively structured organisational network can improve project performance and knowledge transfer. However, the major problem is that organisational networks have not been fully considered in the knowledge management literature. Loosemore (2006) and Harris and McCaffer (1996), for example, argued that well-developed organisational networks are particularly useful for effective access to relevant knowledge and knowledge owners at the right time. Therefore, organisational networks must be deliberately integrated into an appropriate knowledge mapping approach.

2.5 Finding an appropriate focus for knowledge mapping in construction project organisations

2.5.1 Selecting the appropriate components in knowledge mapping

As has been argued by a number of researchers and practitioners, knowledge maps are an effective tool and means to visualise and codify knowledge in construction project organisations (Wexler, 2001, Tiwana, 2002, Plumley, 2003, Liu and Hsu, 2004), but it has been emphasised that the key characteristics and components of construction projects, businesses or organisations must be integrated in knowledge mapping (Grey, 1999, White, 2002, Kim *et al.*, 2003, Liu and Hsu, 2004).

The selection of appropriate knowledge map model components for successful knowledge mapping in construction project organisations is thus essential. In this study, each rational for selecting each of the appropriate knowledge map components is given below.

First, construction actors are adopted as a key component for an appropriate knowledge mapping in this study because construction project-based knowledge is created, owned and used by construction actors in construction projects and construction organisations. In the knowledge management area, it has been agreed that people are at the heart of knowledge and knowledge management, as knowledge owners and knowledge users (Wiig, 1999, Egbu, 2001, Scarbrough, 2003, Thite, 2004).

Second, construction processes are adopted as a key component for the knowledge map model in this study. It has been mentioned that construction projects commonly consist of a various number of phases and sub-processes which have been recognised and agreed a key fundamental unit for construction management and project performance by many researchers and practitioners (Gould, 2004, Al-Reshaid *et al.*, 2005, Tzortzopoulos *et al.*, 2005, Lindahl and Ryd, 2007). In other words, construction projects are a conglomeration of processes which are divided

and classified for effective construction project performance by specific construction actors who have their own specific knowledge and techniques to systematically plan and use management systems and technologies. Therefore, it can be argued that construction processes are a necessary component for an appropriate knowledge mapping in this study.

Finally, knowledge transfer technologies are considered as a key component of the knowledge map model in this study because it has been stressed that technologies like information and communication technology (ICT) are effective in the transfer of knowledge in projects and organisations (Kautz and Thaysen, 2001, Koch, 2003, Daghfous, 2004, Hustad, 2004). Furthermore, it has been argued that knowledge transfer technologies are useful to organisationally improve communications with people in projects and organisations (Carrillo *et al.*, 2002, Koch, 2003, Koskela, 2003, Egbu, 2004).

In order to successfully develop an appropriate knowledge map in construction project organisations, the following key three knowledge mapping components are identified: construction actors; construction processes; and knowledge transfer technologies.

By Kazi (2005), people, process and technology have been considered and adopted as the core components to study existing knowledge in construction organisations before and after learning, as been shown in Figure 2.2.

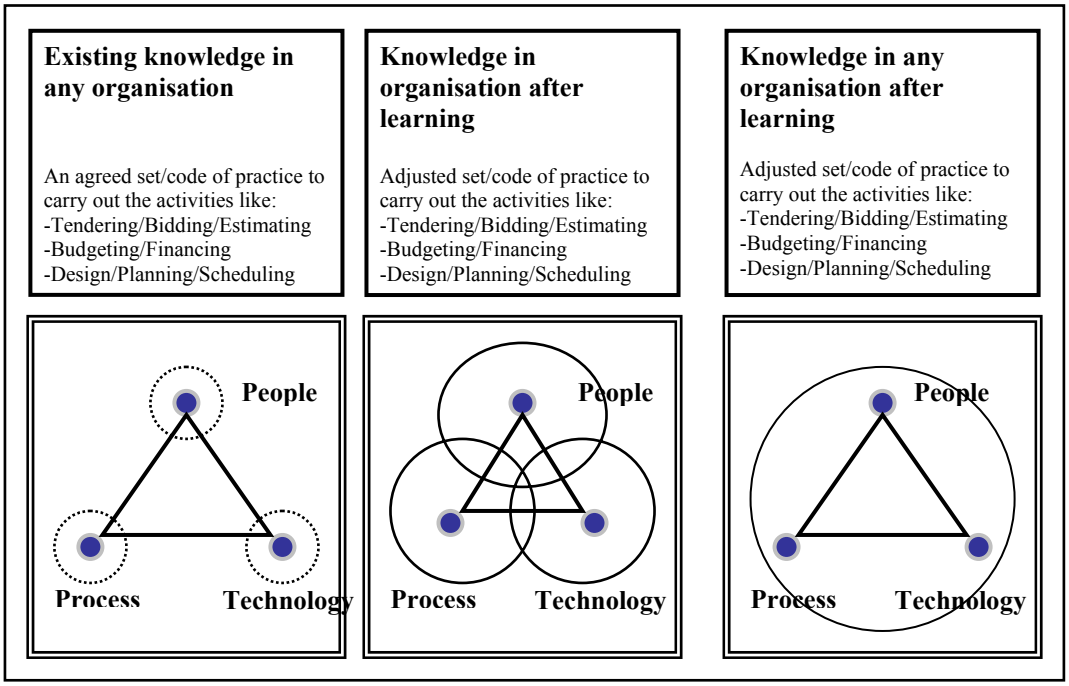


Figure 2.2 Knowledge transfer in construction organisations after learning

[Source: Kazi (2005)]

As has been seen in Figure 2.2, organisational learning can be enhanced through knowledge transfer, integrating people, processes and technology in order to overcome or remove the imperious and impervious thick boundaries and obstacles isolating the construction organisations. Therefore, it can be insisted that project-based learning can be effectively enhanced through systematic knowledge transfer systems which can improve the ability and skills of construction actors in construction project organisations. Ultimately, construction project performance is improved.

However, integrating the key construction project components is difficult in the knowledge management area. In this regard, it has been agreed that knowledge maps can more effectively integrate the key components of project or business, such as knowledge, processes, human resources, technologies and techniques.

2.6 Research questions

As a result of the literature review and synthesis, it has been confirmed that knowledge mapping offers the potential to be a principal component of knowledge management. Tiwana (2002), White (2002) and Hellstrom (2004), for example, agreed that knowledge maps can be used to effectively foster generating, capturing, transferring, codifying, storing and using knowledge in projects and organisations.

A number of types of knowledge map are discussed (Lawless and Smee, 1998, Oughton and Reed, 2000, Koh and Tan, 2006, Driessen *et al.*, 2007), but the maps may be difficult to be used and applied to construction project organisations directly because key characteristics of construction project organisations have not been considered and deliberated. Therefore, a various number of the natures of construction project organisations must be explored and considered in order to successfully develop an appropriate knowledge map for construction project organisations. The following research questions which are interrelated each other are proposed for by the researcher.

■ Research questions

Q1. Is knowledge management an appropriate aspiration for effective project performance and project-based learning in projects and organisations?

Q11. Is knowledge mapping an appropriate tool to improve performance and enhance learning within and across construction project organisations?

Q2. In construction project organisations, how can an appropriate knowledge map be developed for effective project performance and learning?

Q21. What types of construction project components and knowledge

transfer technologies should be part of an effective knowledge mapping approach?

Q22. How should the knowledge map components be integrated?

In order to support and address the above research questions, a systematic and graphic concept model for effective construction project performance and project-based learning in construction project organisations is offered in Section 3.1. The model is utilised to more effectively understand and improve practice, particularly for implementing case study and establishing and demonstrating hypotheses in this study.

2.7 Summary and link

This chapter has reviewed and synthesised the relevant literature on finding the focus of an appropriate knowledge map in construction project organisations. The research questions have been proposed to address and support the knowledge map concept model and the knowledge map components have been suggested and represented for effectively enhancing project-based learning and improving construction project performance in construction project organisations. The next chapter discusses and presents the knowledge map concept model and research hypotheses.

Chapter 3 A Knowledge Map Concept Model and Hypotheses

3.1 Introduction

In this chapter, a knowledge map concept model is offered to investigate the design and development of the knowledge map approach model within construction project organisations. The chapter is structured as follows:

(1) a knowledge map concept model is proposed and described;
(2) key components of the knowledge map concept model are discussed and justified;
(3) a meta proposition and sub-propositions are presented; and
(4) a summary is given with a link to Chapter 4.

3.2 Knowledge map concept model

Companies possess valuable knowledge relating to their products, processes, services, management systems and technologies, but that knowledge has not been often appropriately managed to sustainably produce their competitive advantage (Section 1.2 and Section 1.3). In knowledge-based projects and organisations, knowledge-based benefits and competitive advantages have been predicated on the assumptions that the more individuals and organisations know, the more they can learn and the greater number of learning opportunities are then provided for individuals and organisations (Section 2.2.1).

Within this context, it has been argued that knowledge management has many potential benefits, but in reality that there are fundamental problems (Section 1.3 and Section 2.4). These problems include poor knowledge and knowledge management strategy, unclear terminology, inadequate tools and techniques, and poor training systems (Section 1.3 and Section 2.3)

As a key solution for successful knowledge management it has been argued that knowledge mapping is necessary for successfully building and progressing knowledge management and can provide knowledge users a road map of where

knowledge is located, who has the knowledge and where the knowledge flow (Section 2.3 and Section 2.5). Figure 3.1 is a knowledge map concept model proposed in this study. The variables and their interactions are defined and justified in the following subsections.

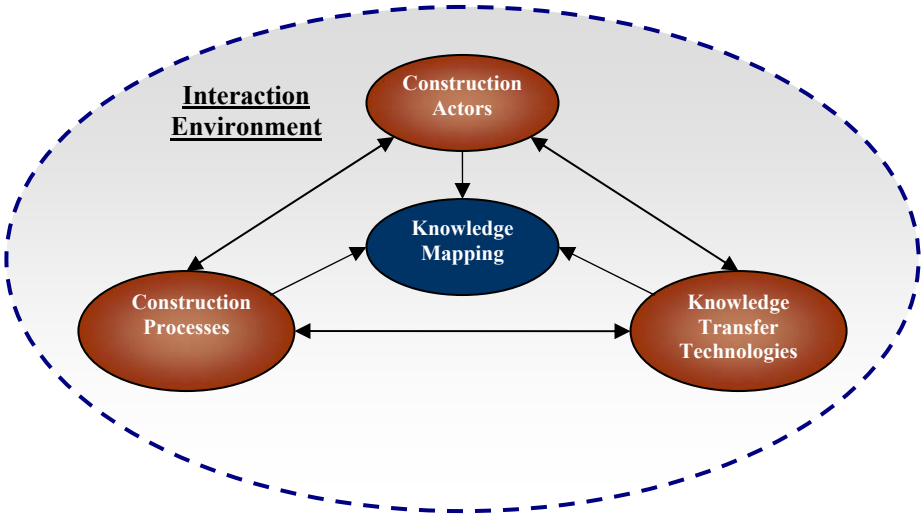


Figure 3.1 Knowledge map concept model

3.2.1 Interaction environment

The interaction environment is taken to be synonymous with the temporary construction project organisation. The temporary project organisation is made up of different construction actors, such as designers, quantity surveyors and contractors, who have different knowledge bases and often operate with different resources and techniques.

3.2.2 Construction actors

The construction actors refer to the different actors within the temporary construction project organisations, such as designers, engineers, contractors and clients (Eldin, 1999, Kamara *et al.*, 2000, Kamara *et al.*, 2002, Egbu *et al.*, 2005). Each actor undertakes a particular role and uses their own specific knowledge for

projects, but need to share and transfer their own knowledge to other actors in order to deliver successful projects.

3.2.3 Construction processes

The successful delivery of projects requires structured processes. Each of construction actors will tend to have its own unique processes. The challenge, therefore, is to integrate these processes.

3.2.4 Knowledge transfer technologies

The knowledge transfer technologies are part of the knowledge management sector. The knowledge transfer technologies are developed and owned by particular construction firms. As a consequence, the performance and integration of these technologies are variable.

3.3 Gap analysis

The knowledge map concept model articulated in Figure 3.1 depicts a holistic and systematic framework for effective knowledge mapping in temporary construction project organisations. This section proposes gap analysis questions to more effectively understand and analyse the interactions between the knowledge map model components which form the bases for a number of research hypotheses. Figure 3.2 presents a gap analysis framework and indication questions are provided in Table 3.1.

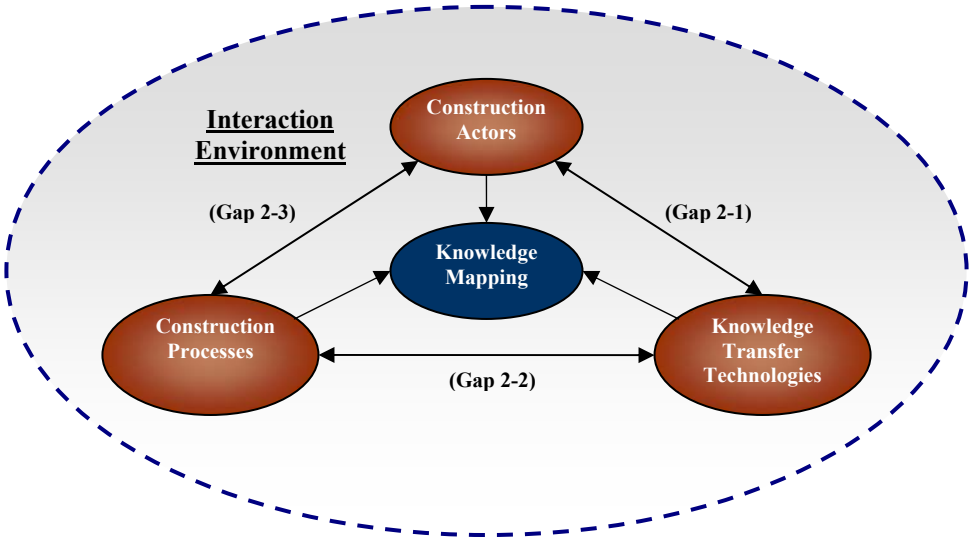


Figure 3.2 Gap analysis framework of knowledge map concept model

Table 3.1 Indicated gap analysis questions generated between the knowledge map concept model components

Gap		Component and Interaction	Indicated Gap Analysis Questions
Project-based	1-1	■ Construction actors	►*Are the construction actors a critical project resource to successfully perform projects within temporary construction project organisations?*
	1-2	■ Knowledge transfer technologies	►*Are the knowledge transfer technologies the effective tools to effectively transfer project-based knowledge within and across temporary construction project organisations?*
	1-3	■ Construction processes	►*Are the construction processes a key project resource to effectively perform and manage projects within temporary construction project organisations?*
Dynamic Capacity	2-1	■ The interaction between the construction actors and knowledge transfer technologies	►*How can the knowledge transfer technologies be used by the construction actors to effectively transfer project-based knowledge within temporary construction project organisations?*
	2-2	■ The interaction between the construction processes and actors	►*How can the construction actors effectively perform and improve the construction processes within temporary construction project organisations?*
	2-3	■ The interaction between the knowledge transfer technologies and construction processes	►*How can the construction processes be effectively performed and improved, using the knowledge transfer technologies within temporary construction project organisations?*

3.4 Research hypotheses

The research hypotheses for this study are as follows.

■ Research hypotheses

Meta-hypothesis:

Knowledge mapping is more likely to promote effective project performance and learning within temporary construction project organisations when the construction actors, construction processes and knowledge transfer technologies are effectively integrated - compared to knowledge maps developed without the appropriate development and integration of construction actors, construction processes and knowledge transfer technologies.

Project-based resources

Hypothesis 1-1: Construction actors

Knowledge mapping is more likely to be successful when construction actors who are critical and necessary to successfully perform construction projects are effectively integrated into the knowledge mapping approach.

Hypothesis 1-2: Knowledge transfer technologies

Knowledge mapping is more likely to be successful when the knowledge transfer technologies integrated as a key knowledge mapping component.

Hypothesis 1-3: Construction processes

Knowledge mapping is more likely to be successful when construction processes are integrated into the knowledge mapping approach.

■ *The interaction between the knowledge map model components*

Hypothesis 2-1: Construction actors and knowledge transfer technologies

Knowledge mapping which integrates construction actors and knowledge transfer technologies will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach

which does not integrate these components.

Hypothesis 2-2: Construction processes and construction actors

Knowledge mapping which integrates construction processes and construction actors will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

Hypothesis 2-3: Knowledge transfer technologies and construction processes

Knowledge mapping which integrates knowledge transfer technologies and construction processes will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

3.5 Summary and link

This chapter has proposed a knowledge map concept model to effectively identify and address the research questions. From this model, a number of research hypotheses have been established.

The next chapter explores and presents the research methodology adopted for this study.

Chapter 4 Research Methodology

4.1 Introduction

Chapter 3 set out the concept of knowledge map model and associated research hypotheses to test the research questions detailed in Section 2.4. This chapter presents and justifies the research methodology used in this study. In this chapter, the structure is as follows:

(1) the nested research methodology used for this study which integrates research philosophy, research approach and research techniques is discussed;
(2) the research philosophy underpinning the research is articulated and substantiated;
(3) the research approach for this study is set out;
(4) the case study design for this study is argued;
(5) the qualitative data collection techniques adopted in this study are discussed;
(6) the qualitative data analysis techniques used in this research are debated;
(7) in the validation, the generalisability, validity and reliability of this research are discussed; and
(8) finally, a summary of this chapter is provided with a link to Chapter 5.

4.2 Methodology: a nested research methodology

It is essential that the design and implementation of the research methodology is appropriate for the focus and nature of the research problem and the questions being explored (Yin, 1994, Wing *et al.*, 1998). This study have taken a nested research methodology approach (Kagioglou *et al.*, 1998). The nested approach ensures that the adopted research philosophy, approach and techniques are both appropriate and compatible. The approach used in this research is shown in Figure 4.1. The constituent research philosophy, approach and technique elements are discussed in the forthcoming sections.

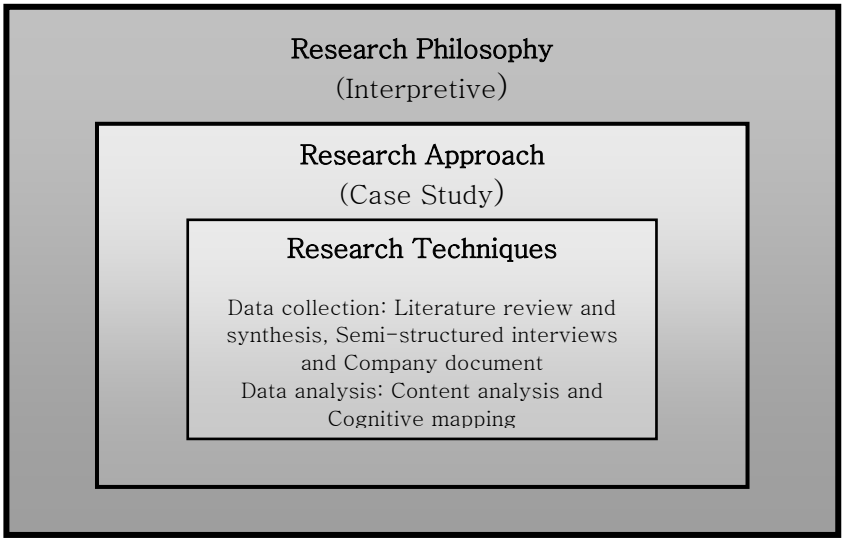


Figure 4.1 The nested research methodology

[Source: Adapted from Kagioglou et al. (1998)]

4.3 Research philosophy

Research philosophy provides a guiding contact for the research approach and research techniques for successful researchers (Smith *et al.*, 1997, Kagioglou *et al.*, 1998). Avison and Fitzgerald (1994), for example, argued that research is merely a method like a recipe if research is performed without any specific philosophical underpinning.

It has been argued that a variety of research approaches are used and combined in research. This means that various research philosophies can be combined on several dimensions (Moore, 1999, Mingers, 2003, Sexton and Barrett, 2003). In research, philosophical approaches can be located on three dimensions: ontology, epistemology and axiology (Burrell and Morgan, 1979, Miles and Huberman, 1994, Collins, 1998, Pring, 2000). This is shown in Figure 4.2 and discussed below.

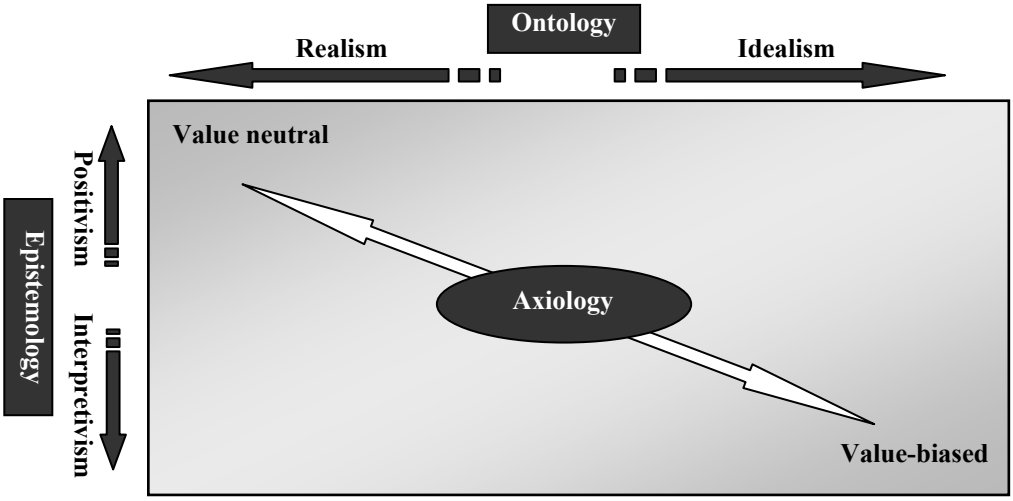


Figure 4.2 Research philosophies on the various dimensions

[Source: Based on Moore(1999), Mingers (2003), Sexton and Barret (2003)]

■ Ontological consideration

Ontology is related to what we know in the world and also, concerns with the nature of reality and phenomenon where a number of researchers seek to investigate their studies (Sayer, 2000). Furthermore, it has been confirmed that a variety of research approaches can be used and combined on research philosophy. Within this regard, Sexton (2003), for example, argued that ontology position can be located along to a continuum ranges from realism at one extreme to idealism at the other.

According to Guarino (1998), realists believe that the social world and natural worlds are different, but it is possible that the basic principles involved in each study are similar. Furthermore, it has been emphasised that human consciousness is a critical factor when the social world is collectively changed by people. On the other hand, idealism concerns with an unknowable reality of the world recognised in different ways (Herz, 1951). Idealists suggest that the ultimate reality is mental or spiritual because the world is realised in different ways experienced and perceived by individuals (Outhwaite, 1987, Sayer, 2000, Sexton and Barrett, 2003).

This study adopts an ontological position which leans more towards idealism. The focus and interaction between construction actors is believed to be a social construction in construction project organisations where various and specific knowledge activities are performed on different construction actor perspectives. However, it is argued in this study that knowledge is in fact difficult to be completely understood by each construction actor because it is always created and generated with different ways and resources by different capacity and knowledge of each construction actor. Therefore, knowledge can be transferred to the others and used within construction project organisations when knowledge is completely understood and used by construction actors. Therefore, it can be said that it is vital to understand and recognise what knowledge in the contexts of construction project organisations and environments of knowledge transfer.

■ Epistemological consideration

Epistemology is concerned with how we come to access the world and also, epistemology position can be located along a continuum ranges from positivism at on extreme to interpretivism at the other.

Positivists believe that knowledge is based on empirical principles in the world; that all evidences must be being tested scientifically; and, the role and task of science is to demonstrate the relationships between both cause and effect (Fuller, 1988, Sayer, 2000, Sexton and Barrett, 2003). Laudan (1996), for example, argued that universal laws governing the world exist and the main positivist epistemology is to identify and prove these general laws. At the other end of the continuous interpretivism argues that the world is understood in unique ways by individuals. In this epistemology, the multiple realities of the world are created and derived by human beings, experiencing and interpreting the world subjectively (Goldman, 1986, Walsham, 1995, Heshusius and Ballard, 1996). In consequence, the main objective of interpretivism is to understand the ways in which the social world is created and experienced by human beings on the subjective basis (Outhwaite,

1987, Joad, 1995, Benton and Craib, 2001, Johannessen and Olaisen, 2005).

This study leans more towards interpretivism. It has been agued that knowledge is created and owned and can be interpretive and used in various ways by individuals, experiencing and understanding the world (Joad, 1995, Johannessen and Olaisen, 2005, Trochim, 2005). Furthermore, it is argued in this study that knowledge is transferred by construction actors and organisations in construction project organisations using a various number of technologies in their own ways. Therefore, it can be said in this study that it is important to understand the contexts of construction project organisations and environments of knowledge transfer which are formed by human actions experiencing and interpreting the world.

■ Axiological consideration

Axiology is related to the value which is perceived in different evaluations by researchers (McNamee, 1998, Rescher, 2004). Axiological position can be located between "value natural" and "value biased" where positivists insist that researchers must maintain a value-free stance because the resultant knowledge is objective and generalised to the other contexts. On the other hand, interpretivists observe that researches are "value-laden" and subjective (Healy and Perry, 2000, Sexton and Barrett, 2003).

The axiological position taken by the researcher leans more towards a value-laden and subjective nature. In temporary construction project organisations, it has been recognised that knowledge is created, understood and used in different ways by each construction actor, but it is vital that knowledge must be transferred when knowledge is commonly understood and can be used by the other actors. In addition, it is important to know that knowledge can be recognised and evaluated as different value by each construction actor because all construction actors have their own subjective capacity and knowledge in the nature. Consequently, it can be said that the value of knowledge can be subjectively interpreted and evaluated

in different ways by the researcher, using owned and experienced knowledge within construction project organisations.

4.4 Research approach: case study

There are diverse research approaches available for research. The collection of a particular research approach is driven by the research objective being progressed. Yin (1994), for example, proposed that this selection is dependant upon three conditions: (1) the type of research question posed; (2) the extent of control a researcher has over actual behavioural events; and (3) the focus on contemporary as opposed to historical events. The following Table 4.1 presents that research approach strategy can be selected in accordance with the three conditions of study (Yin, 1994).

Table 4.1 Relevant situations for different research strategies

[Source: Yin (1994)]

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary event?
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How many, How much	No	Yes
Archival analysis	Who, What, Where, How many, How much	No	Yes/ No
History	How, Why	No	No
Case study	How, Why	No	Yes

Table 4.1 displays the three conditions and shows how each condition is related to five major research strategies: experiment, survey, archival analysis, history and case story. Within this perspective, the appropriate research approach for this research can be adopted. The importance of each condition and the utility and application of each condition to this study, in distinguishing among the five strategies, is discussed below.

In this study, the main objective of research is to answer concerning "Do

knowledge maps have utility and justification/and under what conditions/in large construction company?". Project-based knowledge is transferred in accordance with its needs for effective project performance and project-based learning between construction actors within and across construction project organisations. Within this context, it can be said that the study explores a contemporary phenomenon or contexts of project-based knowledge transfer which are ambiguous and unclear, especially in temporary construction project organisations. Therefore, it can be said that almost all the research strategies excluding the history strategy are appropriate for this study because the historical method is in dealing with the dead past.

Second, the contexts and events of knowledge transfer can not be controlled by the researcher because each context is totally different and also, it is difficult to control the all contexts and construction actors. Therefore, it can be affirmed that the experimental method is not appropriate for this study because experiments can be manipulated by researchers directly, precisely and systematically. In a laboratory setting, for example, an experiment can be often focused on one or two isolated variables.

Third, in order to successfully achieve this study, the researcher has in fact sought to collect the data in depth, such as the interviewees' experiences, know-how, insights and intuitions. Therefore, the survey method is not appropriate for this study because the survey method is more appropriate an effective for data collection in breath than for data collection in depth.

Moreover, diverse company documents which were reported for projects related to this study in the case study company, in particular knowledge management and knowledge mapping, were selected and analysed to effectively support this study. A list of specific company documents collected and reviewed during this study was provided in Section 4.7.1.3.

In summary, this study seeks to gain the in-depth data and the contexts and environments of project-based knowledge transfer can not be controlled or manipulated by the researcher. Furthermore, the study explores a contemporary phenomenon or contexts of project-based knowledge transfer which are ambiguous and unclear, especially within temporary construction project organisations. As a consequence, a case study approach has been selected as an appropriate research approach strategy for this study.

4.5 Case study design

4.5.1 Case study: a single-holistic case study

According to Yin (1994), there are a variety of types of case studies in research approach strategy in which case studies can be classified into four basic types. Each type of case study can be adopted in accordance with the nature of the research (Figure 4.3).

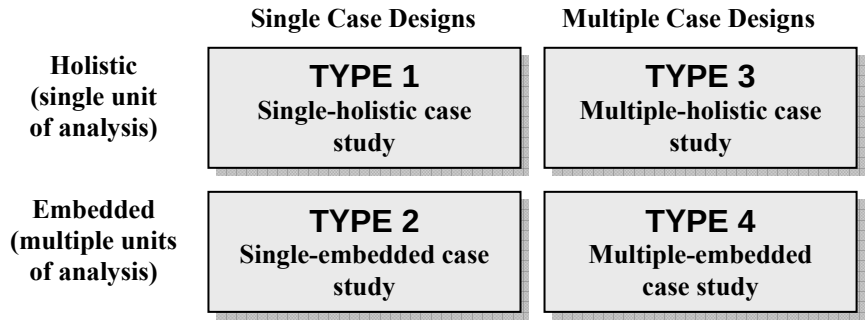


Figure 4.3 Basic types of design for case studies

[Source: Yin (1994)]

As has been shown in Figure 4.3, the basic types of case studies are divided into four types: single-holistic case study, single-embedded case study, multiple-holistic case study and multiple-embedded case study. This study has adopted a single-holistic case study (TYPE 1). The justification for this selection is

discussed below.

First, a key point in designing case studies is related to the selection between single-case design and multiple-case designs. This means that any appropriate case study design must be adopted, prior to any data collection, on whether a single case study design or multiple case study designs are used to address the research questions (Yin, 1994).

It has been argued that the single case study is an appropriate design under several situations and environments: the critical case, an extreme or unique case, and the revelatory case (Yin, 1994: 38-41). The critical case can be used by researchers to challenge, confirm, test and extend a well-formulated theory. In the extreme or unique case, researches can be focused on studying specific case. It is, for example a unique situation in clinical psychology where a specific injury or mortal illness might be so rare that a single case study can be selected for documenting and analysing it. The revelatory case has been proposed as a rationale for a single case study. In the revelatory, a researcher, for example, has an opportunity to explore, observe and analyse a phenomenon previously inaccessible to scientific investigation (Yin, 1994: 38-44).

In the case study design, it has been argued that single case study can be used on combining with holistic or embedded case study. An embedded design can be, for example, compatible that if the main unit is the organisation as a whole, the smallest unit is the individual member and several intermediary units are also important (TYPE 2). In contrast, a holistic design can be used that if the case study investigates only the universal nature of a system or an organisation (TYPE 1) (Yin, 1994: 41-42).

In some fields, the multiple case studies are considered a different methodology than a single case study. The replication logic, not sampling logic, is provided as a key rational for the multiple case designs. Within this context, it has been

emphasised that the logic underlying the use of multiple case studies is the same and also, each case must be carefully selected so that it either predicts similar results or produces contrasting results but for predictable (Yin, 1994: 45-51).

In the multiple case studies, it has been emphasised that each case study needs to be either holistic or embedded. In other worlds, the multiple case studies may consist of multiple holistic cases (TYPE 3) or multiple embedded cases (TYPE 4). The key difference between these two cases is dependent upon the type of phenomenon being researched. In an embedded case, a study may be performed for the conduct of a survey at each case study site and also, each individual case study may in fact include the collection and analysis of highly quantitative data, including the use of survey within each case (Yin, 1994: 50-51).

Consequently, a single-holistic case study (TYPE 1) has been adopted as the case study for this study because this study is to investigate only the universal nature of temporary construction project organisation in ambiguous and unclear knowledge transfer context. Furthermore, the study is to challenge, confirm, test and extend a well-formulated theory, carrying out the in-depth examination to minimise the chances the misunderstanding and misrepresentation and gaining the quality and in-depth data within temporary construction project organisation.

4.5.2 Unit of analysis

In the research methodology, it has been argued by a number of researchers that selection and use of appropriate data analysis techniques are very important for successful researches (Yin, 1994, Marshall and Rossman, 1999, Vaus, 2001, Sharp *et al.*, 2002). In this regard, it has been stressed that unit of analysis is the major entity for successful data analysis, which is being analyzed in the study (Kassarjian, 1977, Barcikowski, 1981, Hopkins, 1982).

Yurdusev (1993), Knapp (1977) and Miles and Huberman (1994), for example, insisted that setting out an appropriate unit of analysis is vital for successful

research. In this study, the unit of analysis was investigated at the interaction environment of the temporary construction project organisation because not only the basis and background of the data collection for this study: project-based knowledge transfer activities, project performance and project-based learning, have been taken place within the temporary construction project organisation (Section 2.2), but also the key knowledge map concept model components: construction actors, construction processes and knowledge transfer technologies, are based on the temporary construction project organisation (Section 3.2).

4.5.3 Selection of the case study

In the case study design for this study, a single-holistic case study was adopted as the research approach (Section 4.5.1). A construction project consulting company called "HanmiParsons Co., Ltd." was adopted as the case study company which satisfied the stratified random sample adopted for this study. The justification for selecting the case study company is discussed below.

In order to find out a representative case, the first consideration was that the case study company needed to meet the key characteristics of construction project organisations which have been already set out in Section 2.2. The first consideration is related to knowledge management and knowledge mapping created and used for knowledge management development because this study was focused on an appropriated knowledge mapping with understanding the key construction project components and confirming the utility and application of knowledge map concept model articulated in this study. The case study company is now operating a knowledge management (system) developed with a knowledge map devised from the taskforce team.

Second, knowledge transfer activities between construction actors and their teams and use of knowledge transfer technologies were considered as a key criterion of selection of the case study company because the researcher needed the experiences and insights of construction actors for holistic and systemic

understanding concerning knowledge transfer activities, knowledge transfer routes, knowledge transfer methods and knowledge transfer technologies within construction project organisations. The case study company is actively promoting use of and knowledge transfer technologies like question and answer system, e-mil system and knowledge management system to effectively transfer project-based knowledge between project teams and their members for successful project performance and project-based learning within and across construction project organisations.

The varieties and number of construction projects performed by the case study company were considered as a criterion of selection because appropriate and rich data can be collected on many and diverse projects experienced and performed by construction actors. HanmiParsons Co., Ltd., as a leading construction project consulting company, has completed more 90 international construction projects and is now performing more 10 international projects per year. The background of the case study company adopted in this study was provided: the geographical location, the homepage, the basic information, and the organisational chart (Section 5.2.1 and Section 5.2.2).

Finally, the capacity and knowledge of construction actors engaged in the case study company was considered as a key criterion because in order to successfully collect the appropriate data from the interviewees, various and rich interviewee candidates needed to meet, in particular the key construction actors in knowledge manager level, project manager level and project member level. It has been confirmed that the case study company HanmiParsons Co., Ltd. has had the appropriate and enough qualification (Section 5.2.1).

4.5.4 Interviewee

The human resources owned in the case study company were proposed as a key criterion for selection of an appropriate and representative case by the researcher. Within this context, the interviewees were drawn from in the knowledge manager

level, project manager level and project member level. This allowed diverse experiences and insights regarding project performance and project-based learning through project-based knowledge transfer.

In order to successfully collect appropriate data for study, interview sample size needs to be decided before conducting interviews. Yin (1994) and Merriam (1998), for example, argued that determining the appropriate sample size is a critical process to successfully collect data for study. In the case study, 15 interview candidates were first selected by the researcher, but the 12 interviews were in fact conducted because new data was not occurred any more. This means that the researcher continues expending the sample size until the data collection reveals no new data (Glaser and Strauss, 1967).

4.6 Research techniques

In this section, the data collection and analysis techniques used in this study are discussed. The data collection techniques consist of a literature review, review of company documentation and semi-structured interviews (Buckley, 1976, Bell, 1993, Sharp *et al.*, 2002). The data collection and analysis techniques are set out below.

4.6.1 Data collection techniques

4.6.1.1 Literature review and synthesis

The literature review and synthesis phase of research grounds drives and continually informs the research argument being proceeded (Guillemin *et al.*, 1993, Hart, 1998, Stanley, 2001, Yisa and Edwards, 2002). The literature review and synthesis for this study has focused on a number of areas: knowledge management area; construction project organisation area; research methodology area; and knowledge mapping area. The main areas explored by the literature review in this study are depicted in Figure 4.4.

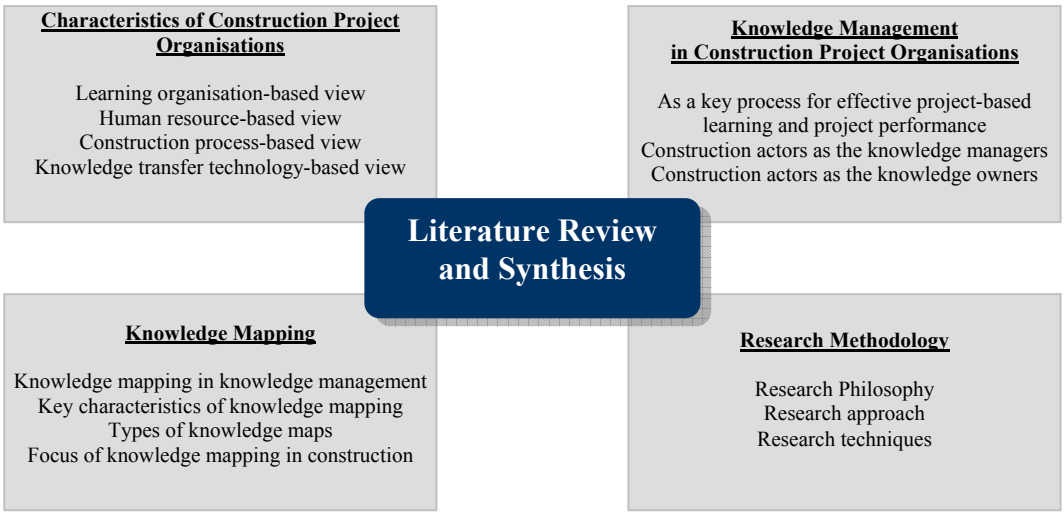


Figure 4.4 Main areas explored by a literature review and synthesis

4.6.1.2 Interviews

Data collection through interviews provided potentially effective method for capturing people's opinions, feelings, practices, insights and experiences (Glaser and Strauss, 1967, Merriam, 1998, Wisker, 2001, Fontand and Frey, 2003). Within this perspective, Biklen (1992) and Breakwell (1995), for example, argued that the interviews are commonly used and flexibly applied as a key research technique in research. The interviews in data collection techniques have been increasingly emphasised as a key technique of data collection method by in research (Biklen, 1992, Merriam, 1998, Wisker, 2001, Fontand and Frey, 2003). There are three broad types of interview techniques: structured, semi-structured and open-ended and unstructured interview (Stewart and Cash, 1974, Wisker, 2001, Robson, 2002, Fontand and Frey, 2003). The types and key nature of the interviews are described below.

● **Structured interviews:** Structured interviews provide interviewees with a set of closed questions which have a range of predetermined answers and the

interviewees can clearly choose their answers, for example “agree” or “disagree”. Structured interviews are appropriate for tightly defined research questions and/or will be guided to qualitative analysis.

● **Semi-structured interviews:** Semi-structured interviews are implemented on the set of semi-structured interview questions which are also made in advance and they are conducted by the conversation between interviewer and interviewee. Interviewees can freely say their opinions on the topics and the data may be rich in gathering people’s opinions, feelings and practice, their experiences.

● **Unstructured interviews:** Unstructured Interviews are a type of interviews where questions can be changed or adapted to gain the appropriate interviewees’ responses. In other worlds, unlike a structure interview the unstructured interviews are performed with informal questions and the respondents can propose their opinions by free conversation in the freely context and the data may be rich on the topic, but in the interviewing context, managing the interviews that can be difficult and filtering and scripting of data would be harder than the other techniques.

As has been mentioned above, it can be recognised that structured interviews can provide cost-effectiveness of data collection and unstructured interviews are more advantageous for gathering data in an exploratory mode. As a key interview type between the two polar extremes, semi-structured interviews can provide not only cost-effective and rigorous data collection methods, but also flexibility to investigate unclear and ambiguous issues. In this study, the semi-structured interview approach was adopted.

In order to successfully conduct the semi-structured interviews, the interview candidates adopted for this study were firstly contacted and provided with a co-operation proposal (Appendix A) including the interview protocol and questions (Appendix B and Appendix C) was then made and delivered to the case study

company. After that, the case study company was answered and determined, providing the fundamental information of the interviewees and the case study company (Appendix D). The following Table 4.2 lists the interviewees and the interview durations.

Table 4.2 A list of interviewees and duration of interviews

Name	Key role	Interview Duration
TWK	Knowledge Manager	**105 Minutes**
JEP	Knowledge Manager	**111 Minutes**
HWJ	Project Member	**85 Minutes**
KTK	Project Member	**95 Minutes**
WKC	Project Member	**96 Minutes**
KIK	Project Manager	**125 Minutes**
KHL	Project Member	**88 Minutes**
JHO	Project Member	**98 Minutes**
KNK	Project Manager	**109 Minutes**
HSC	Project Member	**82 Minutes**
SSK	Project Manager	**75 Minutes**
OGK	Project Manager / Knowledge Manager	**107 Minutes**
12	**-**	**2008 Minutes**

As has been shown in Table 4.2, the 12 interviews were conducted in accordance with the interview schedule (Appendix B). Each interview was between one and a half and two hours in during. All the interviews were tape recorded by a digital voice recorder. After that, all the interviews were transcribed by the researcher and checked by the interviewees.

In order to effectively conduct the interviews, an interview schedule was negotiated between the researcher and the case study company along with the interview semi-structured questionnaire (Appendix A and Appendix B). An interview schedule was developed prior to conducting the interviewees (Appendix B). Table 4.3 is an overview of the interview schedule, corresponding research questions devised by the researcher.

Table 4.3 The interview schedule and corresponding research questions

Part	Description	Questions
Section A	**▪ General information about the case study company ▪ Basic information about the interviewee**	
Section B	**▪ General and specific perception and experience about knowledge map and its key components**	
A	**▪ General perception and experience about knowledge map and its key components**	
A1	▪ General perception and experience about knowledge map	Q1
A2	▪ General perception and experience about construction processes	Q2
A3	▪ General perception and experience about construction actor-based knowledge	Q2
A4	▪ General perception and experience about knowledge transfer technologies	Q2
B	**▪ Interview questions about knowledge mapping in temporary project organisations**	
B1	▪ Appropriate value of knowledge map	Q1
B2	▪ Significance of knowledge map for effective project-base knowledge management	Q1
B3	▪ Benefits of knowledge map	Q1
B4	▪ Who for knowledge mapping in construction projects and organisations	Q2
B5	▪ The major constraints of knowledge mapping in construction projects and organisations	Q2
C	**▪ Interview questions about the key knowledge mapping components**	
C1	**▪ Importance of key project components for an appropriate knowledge mapping**	
C11	▪ Importance of knowledge mapping for knowledge management in construction	Q1
C12	▪ Key knowledge map components proposed by the interviewees	Q1, Q2
C13	▪ Benefits of applying the key knowledge map components	Q1, Q2
C14	▪ The key constraints of applying the key knowledge map components	Q2
C2	**▪ Construction processes in construction project organisations**	
C21, C22	▪ Importance of construction processes	Q1, Q2
C23	▪ Value of construction processes as a key knowledge map component	Q2
C24	▪ More effective construction processes as a knowledge map component	Q2
C25, C26	▪ The reasons and considerations perceived as more effective construction processes	Q1, Q2
C3	**▪ Construction actors in construction project organisations**	
C31	▪ Needs of construction actor-based knowledge during project performance	Q1, Q2
C32	▪ Type of knowledge transferred during project performance and its acquisition methods	Q1, Q2
C33, C34	▪ Importance of construction actors for effective project performance	Q1, Q2
C35	▪ Value of construction actors as a key knowledge map component	Q2
C36	▪ Types of more important construction actors as a knowledge map component	Q2
C37, C38	▪ The reasons and considerations perceived as more important construction actors	Q1, Q2
C4	**▪ Knowledge transfer technologies in construction project organisations**	
C41	▪ Needs of knowledge transfer technologies during project performance	Q1, Q2
C42, C43	▪ Knowledge transfer technologies used and available for effective project performance	Q2

C44, C45	▪ Knowledge transfer technologies officially owned in the case study company	Q2
C46, C47	▪ Importance of knowledge transfer technologies for effective knowledge transfer	Q2
C48	▪ Value of knowledge transfer technologies as a key knowledge map component	Q1, Q2
C49	▪ The types of more effective knowledge transfer technologies	Q2
C50, C51	▪ The reasons and considerations perceived as effective knowledge transfer technologies	Q2
D	**▪ Unsuccessful factors of knowledge mapping in experiences**	Q1, Q2
E	**▪ Key knowledge mapping components proposed by the interviewees in construction project organisations**	Q2

The interviews were conducted in accordance with the interview schedule and the interviewees were asked to provide their perception and insights on the relevant research questions. The basic information on the interviewees and the case study company collected during the interviews was described: job title/position; education; qualification; key techniques and skills; project experiences; the number of projects; turnover per annum; business scope; trade associations; major customers; and the number of staffs (Appendix B).

4.6.1.3 Company documentation

Relevant company documentation was reviewed in order to effectively understand and supplement the interview data. With books, journals and newspaper articles and conference papers, as key secondary data, company documentation has been mentioned for research (Marshall and Rossman, 1999, Sharp *et al.*, 2002). Table 4.4 presents a list of key documentations used during the study.

Table 4.4 A list of company documents used during the study

Document title	Description
Company content matrix	This was a knowledge map produced by the case study company for an appropriate knowledge mapping which was project-based.
Case study report about knowledge mapping	This report was produced to effectively improve and upgrade the knowledge management system by the case study company, which was analysed on a number of the successful and unsuccessful factors.
Case study firm; corporate culture report	This document was a report for effective knowledge share culture improvement, which was produced by knowledge management professionals.

Knowledge management 2010 Plan	This report was produced for successful knowledge share culture enhancement and effective human resource development and management. The document was used to advertise the capacity and competitive advantage of company, as a leading company of knowledge management.
Reports for knowledge management strategy	The documents were produced to effectively cope with difficult knowledge management situation and improve knowledge management system.
Knowledge mapping reports	The case study company produced theses documents which have been used to effectively develop a knowledge map by a taskforce team, the knowledge map has been mentioned as a poor knowledge map by knowledge managers because the map was created without considering people, construction processes, project types and technologies

This subsection has discussed the data collection techniques adopted and used in this study. The next subsection discusses data analysis techniques selected and used in this study

4.6.2 Data analysis techniques

There are various qualitative data analysis techniques in the academic area, for example content analysis and cognitive mapping (Emery and Thomson, 1998, Raudenbush and Bryk, 2002, Lee and Suh, 2003) In this study, two types of qualitative data analysis techniques were used: content analysis technique; and cognitive mapping technique (Rodhain, 1990, Fraser, 1999). Each technique is described below.

4.6.2.1 Content analysis

In order to facilitate content analysis, a computer-aided qualitative data analysis software called "NVivo" was in nature used for this study (Bell, 1993, Bryman, 1998, Fraser, 1999, Silverman, 2004). From NVivo, researchers can create, explore or browse documents or nodes (for example, idea and item) and create or explore the document or node sets or their attributes. Figure 4.5 shows the main NVivo Project Pad which organises NVivo's most common tasks into a series of button panels.

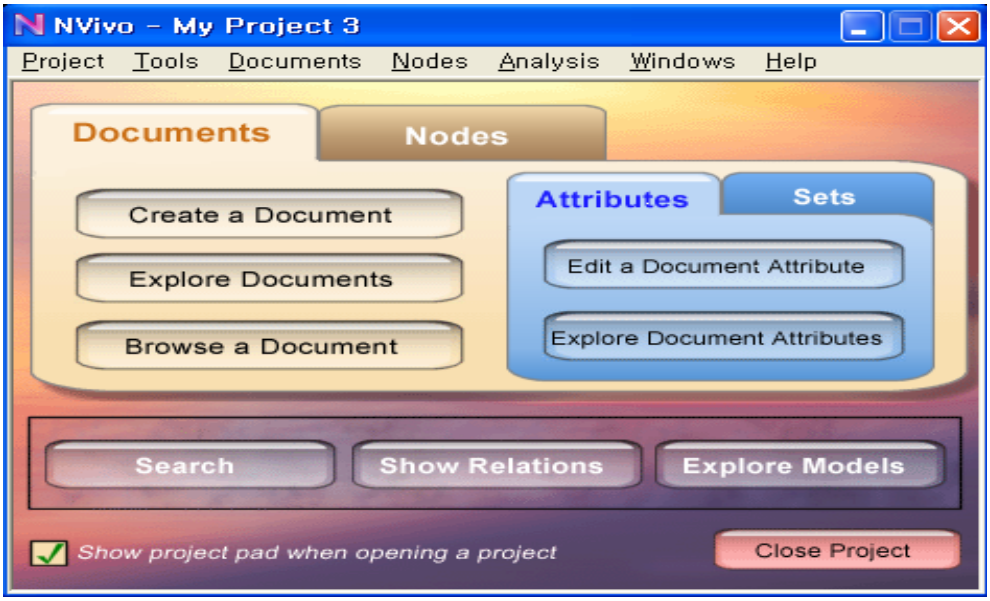


Figure 4.5 The default main screen in NVivo

In this study, NVivo version 2.0 was used for effective qualitative data analysis by the researcher, which is a Windows-based software package. To analyse the interview contents of this study, the interviewees' accounts captured through the semi-structured interviews were first recorded by a digital recorder during interviewing with 12 respondents and were then transcribed the recorded contents to the Korean language in a Microsoft Word 2002 document format. After that, the verbatim transcripts were translated to English by the researcher (Appendix C and Appendix D). It has been recognised that the translation process risks the interviewees' language and message basis altered. Each effort was made to keep the original meaning in place.

In order to effectively analyse the interview contents, each verbatim transcript was then transferred and stored as a project in the NVivo 2.0. Next, as has been shown in Figure 4.6, within each project formed as a document, the researcher selected specific quotations and assigned codes which were then grouped into families and graphically displayed as networks of relationships. In the grouped families, the

key quotations and codes were transferred into a node-centred perspective of the project documents by the Node Explorer. As can been seen in Figure 4.7, the left panel on the window screen shows the free, tree and cases nodes that have been created in the study and the light panel on the window screen shows a list of free nodes which was adopted and used as the main node type in this study because the free nodes is relatively simpler than the tree nodes and can be more effectively displayed and controlled in a folder as a list, but the tree nodes are compulsorily organised into a hierarchy and ineffective for quality data analysis (Bryman, 1998, Fraser, 1999, Silverman, 2004).

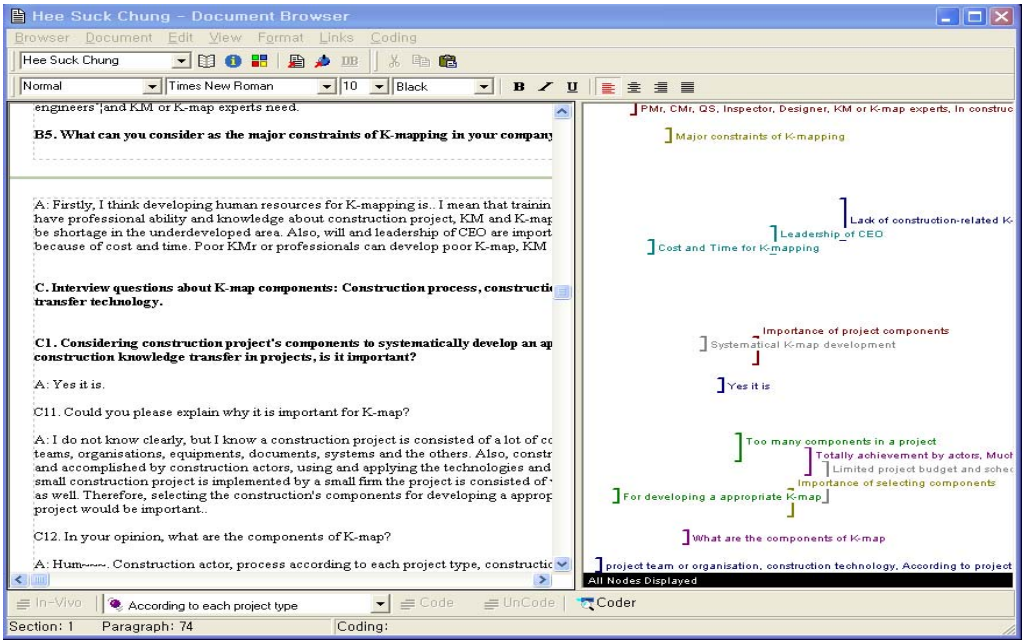


Figure 4.6 The passages of the primary document and specific quotations and codes assigned in NVivo

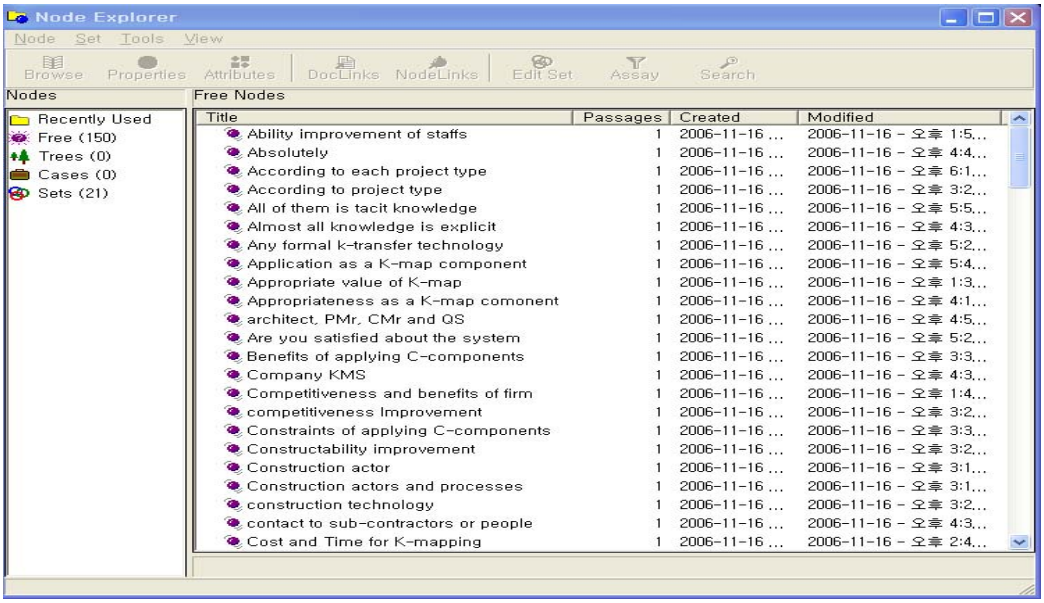


Figure 4.7 The types of nodes in NVivo

In this study, a provisional and unorganised node list was created through initial quotations' and codes' data (Figure 4.7). The researcher identified the provisional nodes in the themes based on phrases or paragraphs in each document, and organised them in a set of lists. In the sets of lists, the nodes were classified into more appropriate ones, modifying the nodes and adding new nodes (Figure 4.8). The final nodes were then grouped and arranged in order to further analyse and present the research data through rebuilding and displaying the relationships between nodes, which was facilitated by the cognitive mapping technique. The next subsection discusses cognitive mapping.

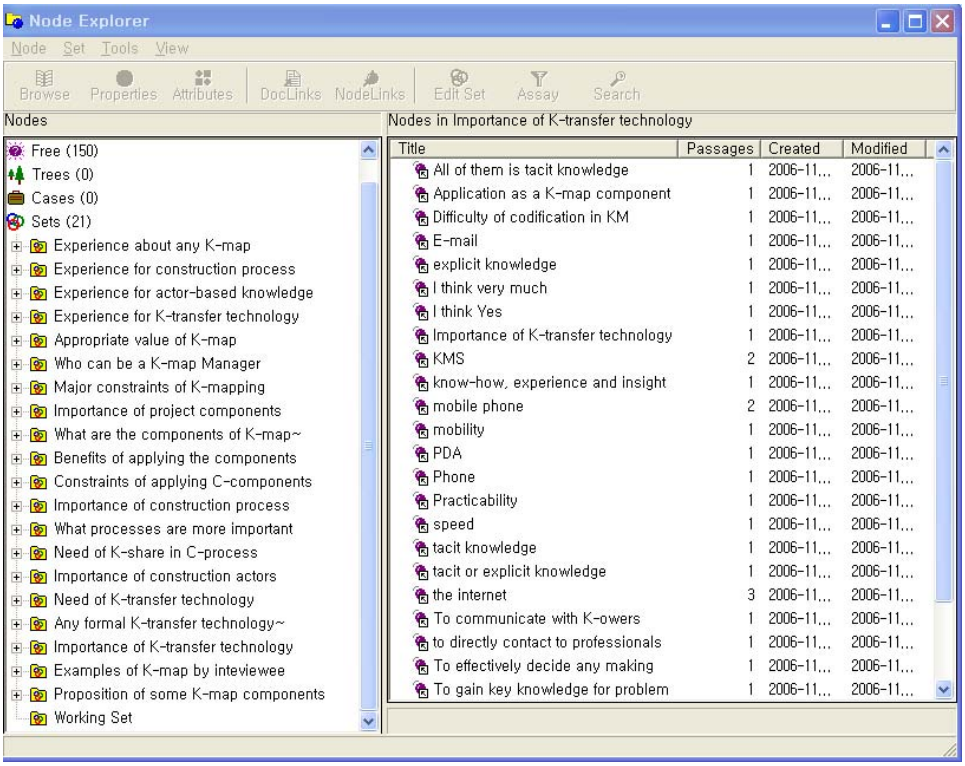


Figure 4.8 The final sets of nodes coordinated in NVivo

4.6.2.2 Cognitive mapping

In this study, cognitive mapping technique was used as a process of creating cognitive maps which were constructed in a way where key concepts were clustered in a hierarchical order in order to more effectively identify, understand, decode and represent the ideas, arguments and actions generated through the content analysis. Eden (1992), for example, insisted that cognitive mapping technique is a useful tool for revealing peoples' subjective beliefs and minds in a meaningful way so that they can be examined not only by the individual for whom the map is constructed, but also by other individuals and groups. Furthermore, it has been agreed that cognitive maps are effective for effective and organisational analysis: the use of repertory grid techniques (Reger, 1990); the systematic coding of cause and effect relationships (Axelrod, 1976); special interviewing techniques

(Bougon, 1983); computer software analyses of interview data (Eden, 1992); and argument mapping (Fletcher and Huff, 1990).

This study was used a cognitive mapping computer software called "Decision Explorer" for effective data analysis and representation because Decision Explorer has been focused to be an effective visualising technique for mapping the interactions and relationships between the key factors or components and contexts (Rodhain, 1990).

In order to successfully construct cognitive maps, the researcher first took the nodes based on the content analysis in a way where they were grouped with key concepts which were identified for each variable in the concept model (Figure 4.8). The key concepts were initially positioned in the white mapping area on the computer screen and the nodes were then clustered in a hierarchical order. In the mapping area, the clustered nodes and key concepts were linked to effectively display and represent their interactions and relationships, using lines and arrows which were used to identify the meaning between the items and concepts (Figure 4.9).

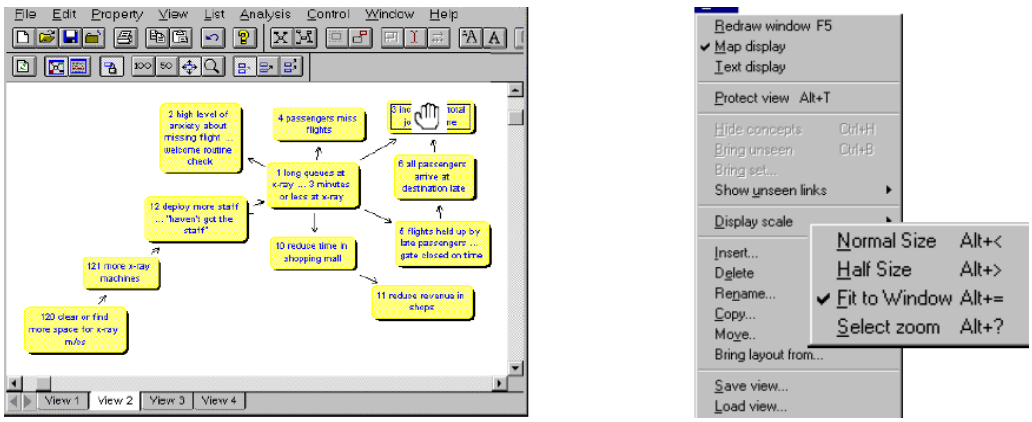


Figure 4.9 An example of linking nodes and concepts in Decision Explorer

As has been shown in Figure 4.9, a cognitive map is composed of the items and

key concepts are linked by lines and arrows. A concept represented one argument, idea, action or technology onn the white mapping area. For example, the main concept in Figure 4.10 is "Benefits of the knowledge map components" whose sub-concepts are "Knowledge management area", "Organisational level" and "Construction project area" which are also hierarchically linked to several nodes (Figure 4.10).

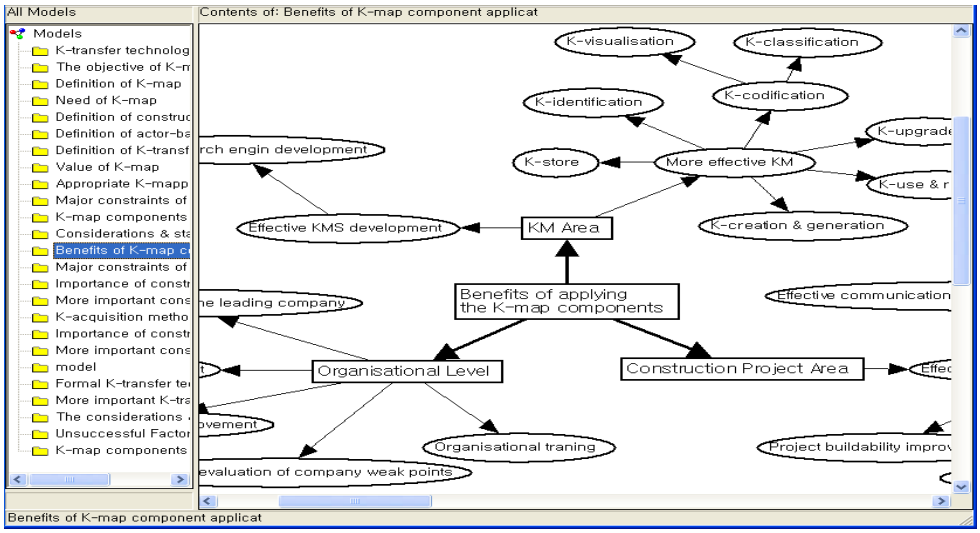


Figure 4.10 An example showing a key concept linking to sub-concepts and ideas

As has been shown in Figure 4.10, all concepts and ideas were hierarchically ordered and structured in the cognitive maps in which they were generally organised in a way in which the major concepts showed outcomes, goals, objectives, key considerations and standards, key issues or key factors; the sub-concepts represented technologies, types of knowledge, areas, key components or key considerations and standards; and the nodes (items) meant key components tools, methods, key actions or unsuccessful factors. Figure 4.11 shows an example of the laddering of concepts.

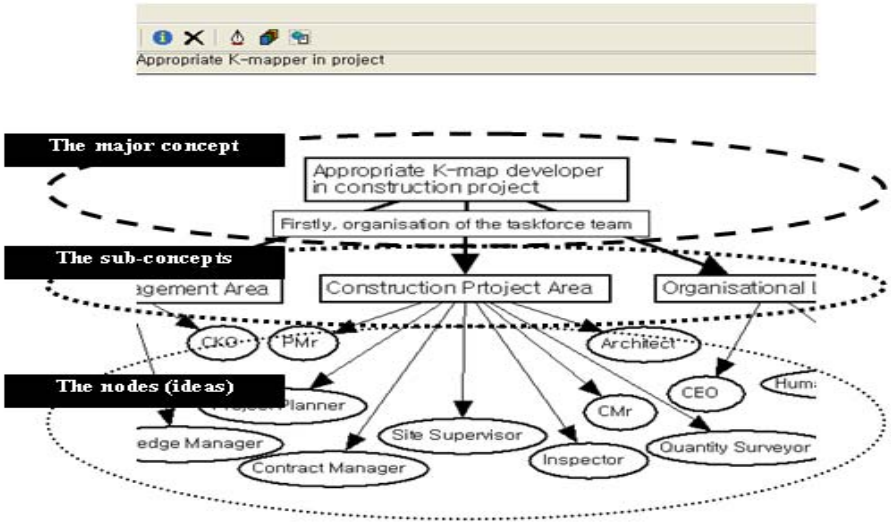


Figure 4.11 An example of a laddering of concepts

In this study, the relationships and interactions among the concepts and items were based and coordinated on causality, similarity, belonging, continuity, contemporary, temporality and supplementary. In order to effectively help understanding the cognitive maps, the cognitive maps were finally synthesised and visualised in various ways by the researcher. The following Table 4.5 is an example of synthesised cognitive maps.

Table 4.5 An example of the final synthesised table

	Area	Unsuccessful factors		
Classification	Knowledge mapping area	Poor compatibility to the other technologies and systems		-Project management information system -Human resource management system -Expert system
		Poor knowledge mapping strategy and theory		-Wrong selection of key knowledge map components -Poor knowledge classification and knowledge visualisation method -Knowledge mapping tools and techniques -User-focused strategy -Human resource-based strategy -Tacit knowledge-based strategy
	Construction project area	Individual area	Poor support and interest of members and staffs (4801)	-Adherence of traditional means and methods (4803) -Rejection against new technologies and learning (4802)
		Organisational area	Poor leadership of chief executive officer and the executives (4703, 4704)	-Poor training and education system for human resource development ((4708) -Insufficient knowledge mapping time and cost (4701, 4702)

4.7 Validation

In the academic area, if a research is performed without relevant and accurate research motivation, research objective and research methodology the research will be failed and just recognised a story or anecdote by people (Denzin, 1978, Hammersley, 1992, Denzin and Lincoln, 2000, Silverman, 2000). To be more accurate, creditability matter of research is to be recognised as the most important factor of academic theses. This means that discussing and justifying the generalisability, validity and reliability of theory in validation is critical for successful researches (Kirk and Miller, 1986, Yin, 1993, Clavarino *et al.*, 1995, Marshall and Rossman, 1999).

In the next sub-sections, validation of this study is discussed on generalisability, validity and reliability.

4.7.1 Generalisability

The term "generalisability" is a standard aim of researchers and can be commonly achieved by sampling procedures. Vogt (1993) and Silverman (2000), for example, agued that generalisability can be realised by conclusions based on data collected by relevant case study.

In order to successfully complete this study, the researcher deliberately explored and used a multitude of means and methods because the new knowledge generated during the study must be able to be used and applied as universal knowledge to the other future studies (Yin, 1994). Within this perspective, an appropriate literature review and synthesis was used to devise the knowledge map concept model (Chapter 2) which was created an appropriate knowledge mapping model to improve project performance and project-based learning through effective knowledge transfer within and across temporary construction project organisations (Section 3.2) and also, the research data collection and presentation

techniques for this study were investigated and used on the systematic frameworks and procedures (Section 4.6).

4.7.2 Validity

By Silverman (2004), it has been mentioned that the term "validity" is recognised as another word for "truth" in research. Furthermore, it has been argued that "validity" is related to the extent to which an account accurately represents the social phenomena to which it refers (Hammersley, 1990). There are a variety of types of validity in the academic area. In this point, Yin (1993) argued that "validate" can be sorted into three types of validity in order to create designs in case study design: construct validity; internal validity; and external validity. The definition and feature of each validate is as follows.

■ Construct validity is related to the use of multiple instruments and measures which can operate the constructs of interest in a study.

■ Internal validity can be accomplished throughout the specification of the unit of analysis, the development of priori rival theories and the data collection and analysis to test and demonstrate the theories.

■ External validity is connected with and cans be achieved through the specification of theoretical relationships.

Within this perspective, it has been argued that multiple instruments and methods, sometimes overlapped, must be used and applied to demonstrate validity of case study performance in researches, such as literature review and synthesis for research focus, problem, concept model and hypotheses and case study design for data collection and analysis (Hammersley, 1992, Marshall and Rossman, 1999, Vaus, 2001, Silverman, 2004). Above all things, Silverman (2000) and Denzin (1978) insisted that triangulation method is referred as a critical means to get "true" on a context by combining different ways and recognised as a key

mechanism to overcome bias and misleading of research. Four types of triangulation methods have been proposed to overcome problems of bias and validity by researchers: data triangulation; methodological triangulation; theory triangulation; and, investigator triangulation (Denzin, 1978, Kirk and Miller, 1986, Silverman, 2000, Robson, 2002). In this study, the three types of triangulation were utilised excluding investigator triangulation to increase validity.

First, in terms of data triangulation, this study involved a set of interview protocol and a series of interviews conducted during the case study. Furthermore, various key players were involved in case study to collect the diverse perspectives.

Second, in terms of methodological triangulation, this study used a case study design, which provided an opportunity to closely investigate variables and their interrelationships and interactions. It is also used a multitude of research techniques including literature review, company document review and interviews.

Finally, in terms of theory triangulation, empirical findings were analysed, comparing with existing theories to corroborate the evidence and enrich the empirical results, offering a multiple of perspectives.

Furthermore, an interview co-operation proposal and a set of interview protocol were proposed to gather relevant data from the interviewees (Section 4.5). According to Yin (1993) and Vaus (2001), it has been argued that validity and reliability which are useful evaluation method for case study research have often been considered and emphasised as the method for quality assessment of research. Reliability can in fact be executed through the use of formal case study protocols and the development of case study database (Yin, 1993).

In this study, in order to effectively demonstrate validity of the research, multiple and triangulated data collection processes and methods were used and applied. Firstly, archival method which includes journal papers, books, the internet data,

theses and company documents was used for data collection for research focus development. In this step, a number of generic and specific literatures were reviewed and synthesised. Furthermore, the interviews in a single case study was performed to collect data, proposing a series of interview protocol, reviewing company documents and presenting and providing case study report (Appendix A, B, C and D).

In order to ensure internal validity, various specifications in the study were employed, providing and deploying integrated research questions, hypotheses, a concept model and gap analysis framework and questions. In these specifications, explicit processes and methods were proposed and carried out.

Finally, external validity of this study was achieved through a systematically developed case study design in the research design. In the design, the processes were clearly elucidated. A stratified random sampling strategy for the case study was suggested including sample size, unit of analysis and selection of sample for the interviews (Section 4.4). Therefore, it can be said that the results of this study generated by the case study can be allowed and provided to the other researchers and the methodology of research adopted and used by the researcher can repeatedly be used and cited to the other researches.

4.7.3 Reliability

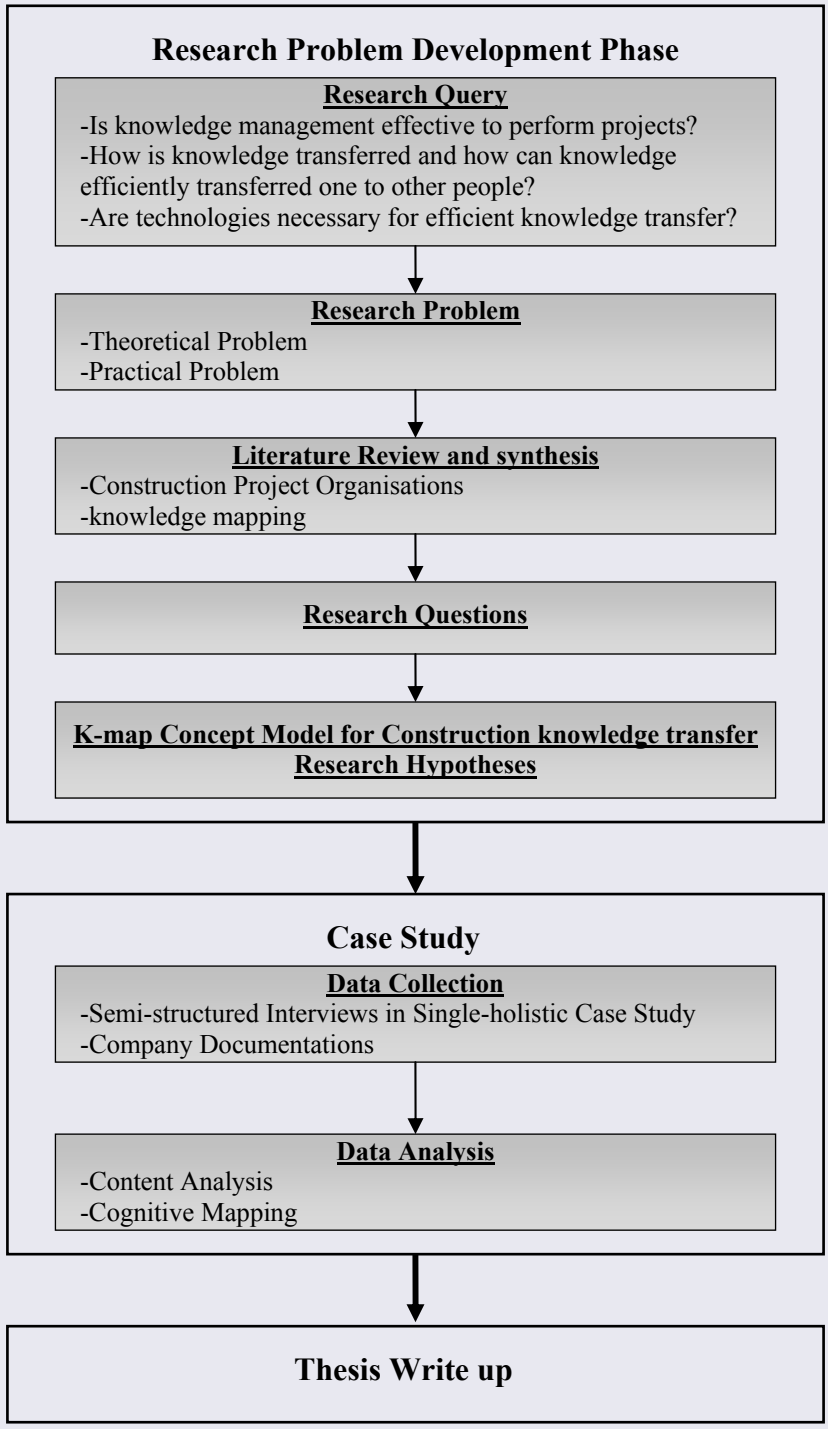
The term “reliability” can be called as a formal document for case study. Yin (1993), for example, argued that researchers can employ formal case study protocols and case study database for ensuring study reliability. The case study protocols must be able to be used in the other cases or researches and also, the case study database must be able to be provided as a way for the evidence of case study manuscript. By Hammersley (1992), it has been agreed that “reliability” is related to the degree of consistency and also, research findings generated by case study must be able to be used and applied to the same category by the same researcher or by the other researchers on the different situations.

In order to ensure the reliability of this study, multiple formal documents were firstly created and proposed to the others: overall research methodology model and process (Section 4.2 and Section 4.8). At the exploratory phase, a set of interview co-operation proposal and semi-structured interview protocol were articulately devised and proposed to the case study company for effective and successful interviews (Appendix A and Appendix B). Interview agreements then offered to the interviewees (Appendix C). In order to effectively and successfully conduct the interviews, the interview schedules were developed and used to reduce biases of misleading of the potential interviewees and researcher (Section 4.6.1.2). Before conducting the interviews, the interview protocol and interview schedules were reviewed and a pilot interview was tested by peers of the researcher who have enough experiences and ability in the same academic and industrial area. The interview contents were recorded and transcribed by the researcher, using a digital voice recorder.

4.8 Overall research methodology model process in the research

In Chapter 2, an appropriate literature review and synthesis were performed in order to discuss what the key issues of research are and what the research questions are. After that, a concept model was proposed and the gap between the components of concept model was then analysed (Section 3.2 and Section 3.3). The research hypotheses based on research questions, the concept model and gap analysis were devised (Section 3.4). In order to systematically execute and demonstrate the concept model and research hypotheses, a nested research methodology was discussed and proposed, which consists of research philosophy, strategy and techniques (Chapter 4).

Figure 4.14 shows the research methodology process for this study.



Note: Iterative Feedback Loops between phases will occur, but have not been shown in the diagram to enhance clarity

Figure 4.12 Research Methodology process used in this study

4.9 Summary and link

This chapter discussed the research methodology used in this study. A nested research methodology was used which consisted of research philosophy, approach and techniques.

The next chapter analyses and represents the key results and findings of the case study.

Chapter 5 Research Findings

5.1 Introduction

This chapter presents the key research findings from the case study phase. The chapter is organised as follows:

(1) the background of the case study company is described;
(2) a summary of the background of the interviewees is provided;
(3) the key results of the interviews are given;
(4) the results of the hypotheses testing are presented; and,
(5) a summary of this chapter is provided with a link to Chapter 6.

5.2 Background of the case study company

5.2.1 Description of the case study company

HanmiParsons, the case study company, positions itself as a leading construction consulting company in the Republic of South Korea. The company was established in 1996 through a joint venture with U.S.A-based Parsons, an international engineering and construction management company. The strategic aim of the joint venture is to develop its market competitiveness in the Republic of Korea and, in ding so, increase its market share. As shown in Table 5.1, the case study company completed 90 projects in 2006. The Construction Association of Korea (CAK) awarded HanmiParsons the title of the best construction project management consulting company in South Korea, in 2006 (http://www.cak.or.kr).

The following Figure 5.1 is the front page of the HanmiParsons Co., Ltd. homepage captured on the http://www.hanmiparsons.com and the key information of the case study company is shown in Table 5.1.

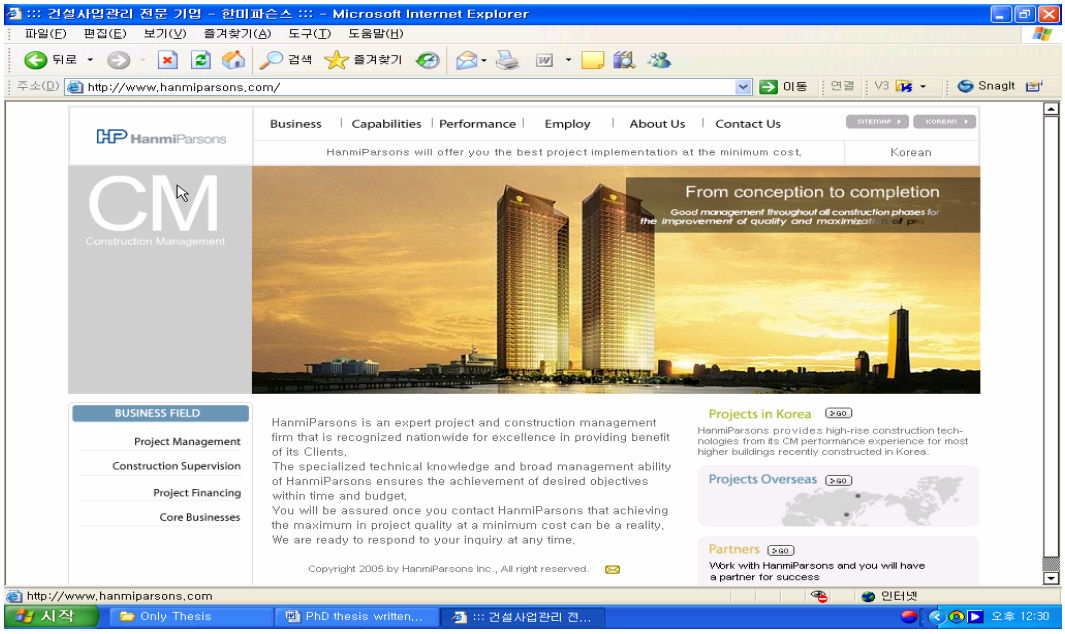


Figure 5.1 The homepage of the case study company

[Source: Captured on http://www.hanmiparsons.com]

As has been seen in Figure 5.1, the HanmiParsons Co., Ltd. homepage can be searched in English, Korean and Chinese languages. In this study, the most important point is that all the HanmiParsons Co., Ltd. staff use the knowledge management system on its homepage. The system allows staff to share project and business-based knowledge, including project management-based knowledge, construction supervision-based knowledge and project financing-based knowledge.

Table 5.1 Summary of HanmiParsons Co., Ltd. (July, 2006)

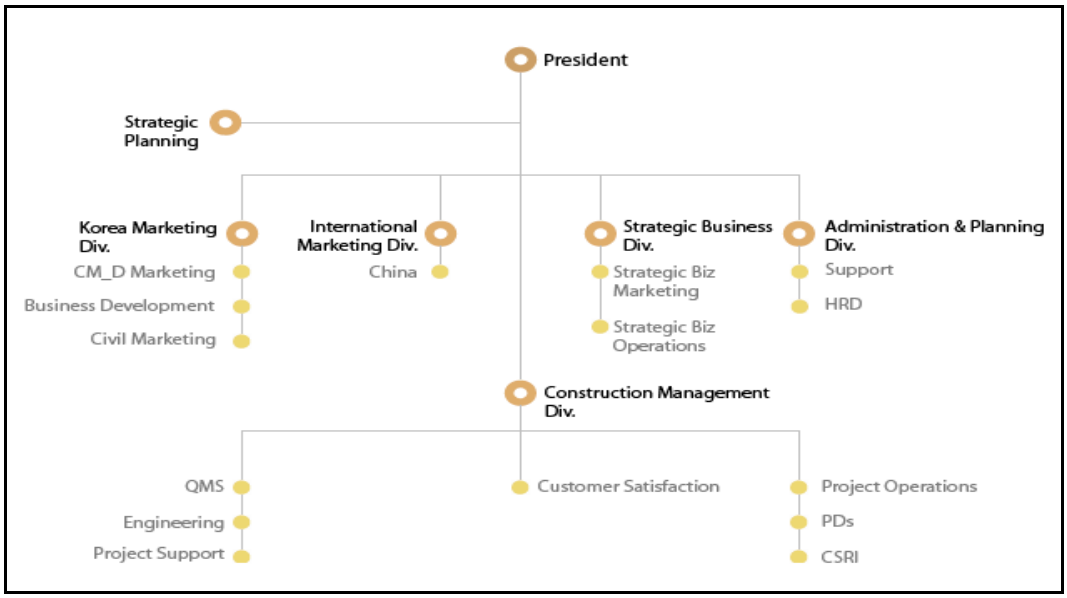
Name of company	**HanmiParsons Co., Ltd.**
Project No.	90 Projects
Major customers	Organisations in Private Sector, Organisations in Public Sectors, Ministries of Korean Government, Multinational Enterprises, Universities…etc
Project Types	High Rise Buildings, Residential Complex, Official Buildings, Commercial Buildings, SOC/Infrastructure, Remodeling Projects, Industrial Facilities, Education/Cultural Facilities, Sports Facilities, Medical Facilities, Tourist Facilities, Religious Facilities, Housings…etc
Establishment	1996 Year
Geographic Coverage	Global
Turnover per Annum	45 Million Pounds

Trades	Project Management (PM), Construction Management (CM), Project Financing Assistance (PFA), Property Management
Trade Associations	Morgan Stanley, Kookmin Bank, Korea National Housing Corporation, National Tax Administration, Busan New Port Co., Ltd., Samsung Heavy Industries, Samsung TESCO, Samsung Electronics, Seoul Municipal Government, Suwon City Government, Hyundai Development, Hilton Hotel, Posco Development, British American Tobacco, Canadian Embassy, Sungkyunkwan University….etc
Business Scope	From Planning to Maintenance in Construction Industry
Qualifications & Certifications	Architect (300), Registered Construction Engineer (140), Registered Architectural Designer (25), PMP (10)
Permanent staff	342 Staff
Temporary staff	13 Staff

As shown in Table 5.1, HanmiParsons has 355 staff, including 13 temporary staff. It has a number of major customers in both private and public sectors, such as Korean government ministries, multinational enterprises and universities. Figure 5.2 shows the organisational structure of HanmiParsons. It is a functional structure built with the aim of promoting effective communications and knowledge transfer between organisation members and their teams across divisions and departments (http://www.hanmiparsons.com). It is interesting to note, however, that the anticipated benefits of the structure were contested by the interviewee project manager OGK, in his observation that:

> *"You can recognise structure of our company when you search the homepage of our company….The structure is a closed organisational structure. In the company, it is a big problem that each division and project team can be isolated from the others. I think that it is very difficult to have good communications and relationships with the others within and across the departments and project teams. So, I can guess that data, information…knowledge can not effectively be shared and transferred and…Maybe… projects will not be able to perform effectively. However, if we have an effective system or technology for effective knowledge transfer and knowledge share between staffs and team members…and their divisions and teams within this company we can more effectively perform our tasks or projects, gaining knowledge related our tasks and projects from the technology. I think we need to try*

for effective knowledge use. That is it."



Key

CM: Construction Management
Div.: Division
PDs: Project Development Team
CSRI: Construction Strategy Research Institute
HRD: Human Resource Department
QMS: Quality Management Team

Figure 5.2 The organisational structure of the HanmiParsons Co., Ltd.

[Source: Captured on http://www.hanmiparsons.com]

5.2.2 Description of interviewees

This section describes the background of the interviewees. Table 5.2 provides the key information about the interviewees: name, job title and role, education, qualifications and experiences.

Table 5.2 Basic information of the interview participants (July, 2006)

Name	Title/Role	Education	Qualification	Experience (Year)
TWK	Knowledge Management	Master	Project Management Professional, Registered Construction Engineer	3.5
JEP	Knowledge Management	Bachelor	No	2.5
JHO	Construction Management	Master	Registered Architect, Construction Engineer	11
KTK	Construction Management	Bachelor	Project Management Professional, Registered Construction Engineer	10

WKC	Human Resource Management	Bachelor	Construction Health & Safety Manager	16
KHL	Construction Electrical Management	Bachelor	Registered Construction Electrical Engineer	15
HWJ	Contract Management	Master	-	3.5
HSC	Construction Management	Master	Registered Architect	16
KIK	Project Management	Master	Project Management Professional, Registered Construction Engineer	23
KNK	Project Management	Master	Registered Architect & Construction Engineer	23
SSK	Project Management	Bachelor	Project Management Professional, Registered Construction Engineer	20
OGK	Project Management	Master	Project Management Professional, Registered Construction Engineer	19

Knowledge managers

Interviewee TWK is a construction engineer and manages organisational knowledge, dealing with construction actor-based knowledge. In the company, his key role is to manage the knowledge management systems and to create a knowledge sharing culture. In order to effectively manage organisational knowledge, he has taken part in a number of international workshops and seminars (Appendix D). The interviewee knowledge manager TWK describes his role as follows:

> *"You know I am working as a knowledge manager in this company…but you know it is very difficult to manage knowledge…because I do not have enough knowledge and skills about knowledge management. I mean my major is construction engineering and I have not worked in knowledge management area. This is the first time in my experience…… so difficult to improve knowledge creation and sharing culture in this company"*

Interviewee JEP is an associate engineer and knowledge manager. In the knowledge management team, her key role is to find out specific project-based knowledge and construction actor-based knowledge (Appendix D). Within this context, knowledge manager JEP describes her role as follows:

"In this company, one of my tasks in the research centre is to make and generate key issue reports, which could be needed by construction workers like construction engineers, project managers and construction managers in order to perform construction projects. So I am always studying and thinking about what the core and necessary knowledge is and when and where the knowledge needs."

Project members

Interviewee JHO is working in the architectural design division of the company. He has worked as a project tem member in a number of big projects, such as the Samsung TESCO Project and the APT and Commercial Building Project in the Republic of Korea. These experiences enable him to develop a high level of project-based knowledge; including insights, know-how and design skills (Appendix D). The interviewee knowledge manager JHO describes his role as follows:

"You know…my task is to manage the gaps between design and construction in construction projects. So knowledge management is very useful….if I have got data about design management…"

Interviewee KTK has worked as a contract manager before and he works as a construction engineer. He has taken part in some big international construction projects, such as the ASEM Project in the Republic of Korea and the Plaza Rakyat Project in Malaysia (Appendix D).

Interview WKC is a human resource manager and construction health and safety manager and has worked as an organisation culture manager to improve effective knowledge management, human resource management (HRM) and human resource development (HRD) in the company. He now has an interest in developing effective knowledge sharing cultures: its effective improvement and

individual and organisational training improvement, and developing appropriate knowledge maps (Appendix D). Within this context, project member WKC stressed the following:

> *"we have an interest that knowledge map is a key tool and system for effective personal and organisation training, HRD and HRM because the department, as a personnel management division, is related to engagement and deployment of human resource. So, we have already recognised the value and need of knowledge map"*

Interviewee KHL is a construction project member and construction electrical engineer and has worked in construction projects, such as the Shinsegae Department Store, the Ulgin Atomic Energy Station Project in the Republic of Korea, the ASEM Project and the Great Channel Project in Libya (Appendix D). Within this context, the interviewee KHL describes her role as follows:

> *"I have heard and experienced. To be honestly, this company is second company in my life. Firstly, I have worked in Dong-A construction company as an electrical manager of construction project after that, I have worked POSCO as a construction manager. I am now working in HamiParsions Co. Ltd., as an electrical manager."*

Interviewee HWJ is an associate researcher and has worked in the contract management department. He is now working as a cost manager in the commercial building project in the Republic of Korea (Appendix D). The interviewee HWJ describes his role as follows:

> *"In my case, I can not say about it in my company, but I can say in my task or role for projects. I have actually received many questions related to contract and cost management throughout website, e-mail or mobile phone because my work is related to contract and cost management."*

Interviewee HSC is an architect and has worked as a designer and project member in a number of construction projects, such as the Housing Building Project and the APT Project in the Republic of Korea. (Appendix D). Within this context, project member HSC describes as follows:

> *"……and I have job experience as an architect about 12 years and know-how, skills and techniques, but I do not know about construction management and how it works clearly."*

Project managers

Interviewee KIK is a senior managing director in HanmiParsons and he has about 23 years of construction project experiences including projects, such as the Broadcasting Station Project, the Samsung TESCO Project and the Atomic Energy Station Project in the Republic of Korea and the Oil Plant Project in Libya. Furthermore, he is a registered project manager and construction engineer in Korea (Appendix D). The interviewee project manager KIK describes his role as follows:

> *"I know what you mean… I have worked as a construction engineer in projects and…. I have experiences as a project member and project manager more 10 years in some projects, such as the Atomic Energy Station Project and the oil plant project in overseas. Therefore, I know what construction processes…construction actors are… Moreover, I have taken part in developing the knowledge management project in this company, as a taskforce team member."*

Interviewee KNK works as a senior director of the project management section and he is also a senior construction manager. He has worked on several big international construction projects, such as the Housing Building Project in Korea, the Hofuf Housing Project in Saudi Arabia and the Dabble Bay Condomium

Project in Singapore (Appendix D). Within this context, project manager KNK describes as follows:

> *"I know what construction processes are…. because I have worked as a construction engineer and I now work as a construction engineer and project manager. Therefore, my peers and friends think that I have good knowledge. In this point, I have a number of questions about projects because…I have already mentioned that I have got many job experiences and careers in the construction industry, as a site manager, site supervisor, construction manager, project manager…and…um…that is it.."*

Interviewee SSK is a managing director of the company and he has worked as a project manager and architect on previous construction projects, such as the Tower Palace Project and the Shinsegae Department Store Project in the Republic of Korea and the Greater Water Channel Project in Libya (Appendix D). The interviewee SSK described his role as follows:

> *"In my experiences, I can guess that construction processes at the pre-construction stages are more important because I have worked as a construction designer and site supervisor in construction projects, such as department store projects, housing building projects and the greater water channel projects in overseas….. In these experiences, I believe that design processes at the pre-construction stages are more important. That is……"*

Interviewee OGK, he is a managing director in the case company and expressed his role as a project manager in projects. He has worked as a civil engineer and cons manager in some projects, such as housing building projects, sport facility projects and APT projects in South Korea and overseas (Appendix D).

In this section, a summary of the interviewees' background and roles has been provided. The next section presents the key research findings.

5.3 Key findings in the case study data

5.3.1 Introduction

The research findings described in this section are based on the data collection (Section 4.6.1) and data analysis techniques (Section 4.6.2) used for this study. The key aim of this study was to understand construction project organisation and application of knowledge mapping with the context of a large construction company in the Republic of Korea. In so doing, the utility and validity of the knowledge map concept model (Section 3.2) was investigated.

5.3.2 The general perception on the role and nature of knowledge mapping

In this section, general perception of knowledge mapping based on the interviewees' experiences is presented and also, the nature and role of the key knowledge map model components articulated in Section 3.2 are assessed.

5.3.2.1 The generic perception of the definition of the knowledge mapping

In Section 2.3.3, knowledge mapping was defined as a key process and tool to effectively visualise and map knowledge resources and their interactions. The interviewees were asked to provide their views on the definition of knowledge mapping within construction project organisation.

General perception of project managers on the definition of knowledge mapping

In the case study, all of the project manager interviewees know about knowledge

maps or have used knowledge maps. Project managers KNK and OGK, for example, have been a knowledge map developer in a taskforce team charged with general knowledge management system development. On the other hand, Project managers KIK and SSK have used a knowledge map user in the case study company. The following Figure 5.3 - 5.5 are the cognitive maps of each of the project managers which present key aspects of their perception of what constituent knowledge mapping.

The interviewee project manager SSK, for example, emphasised that knowledge mapping is a necessary and component (2220, 2221) for effective knowledge management (2211, 2215, 2219). Knowledge maps, in particular, can be used for effective knowledge visualisation and classification (2209, 2210, 2213). Project manager SSK expressed his view of knowledge mapping as follows:

> *"Knowledge maps may be effectively used as a critical tool to knowledge management if the position of knowledge and knowledge owners, such as experts, are identified and visualised in knowledge maps. This means that we can generally know where the source of knowledge is located and where the source is given from through knowledge maps."*

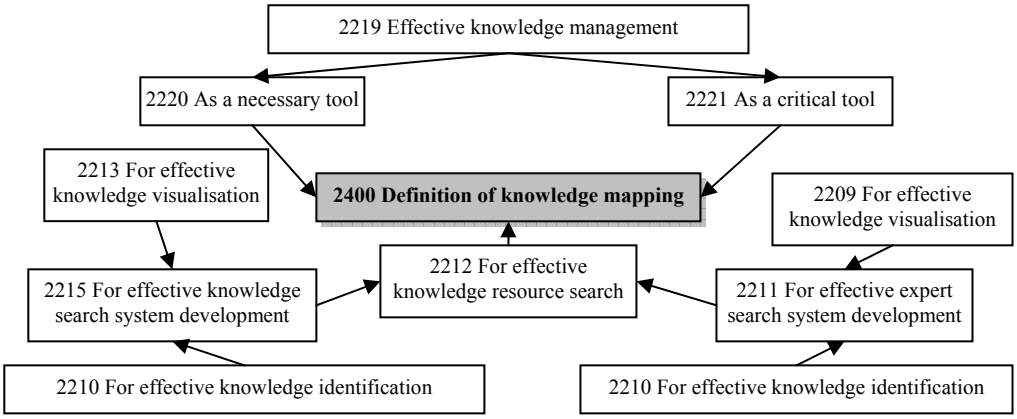


Figure 5.3 A cognitive map of project manager SSK on the definition of knowledge mapping within construction project organisations

In his experience, project manager KIK noted that project performance (2121) can be improved by effective knowledge transfer and knowledge sharing (2119) in projects and businesses through construction workers being able to more easily and quickly access and gain right knowledge at the right time (2110, 2111, 2112, 2115). As a result, it was confirmed that capability of the staff and knowledge capital of the company can be improved (2116, 2118). Within this context, Figure 5.4 presents a cognitive map on the definition of knowledge mapping. Project manager KIK describes the key focus of knowledge maps as follows:

> *"I think that knowledge maps may be able to be effectively used to find knowledge, data and information and key construction workers…..and knowledge owners like project managers and designers and project performance may be improved with effective knowledge transfer. As a result, knowledge of company and its members may be nurtured."*

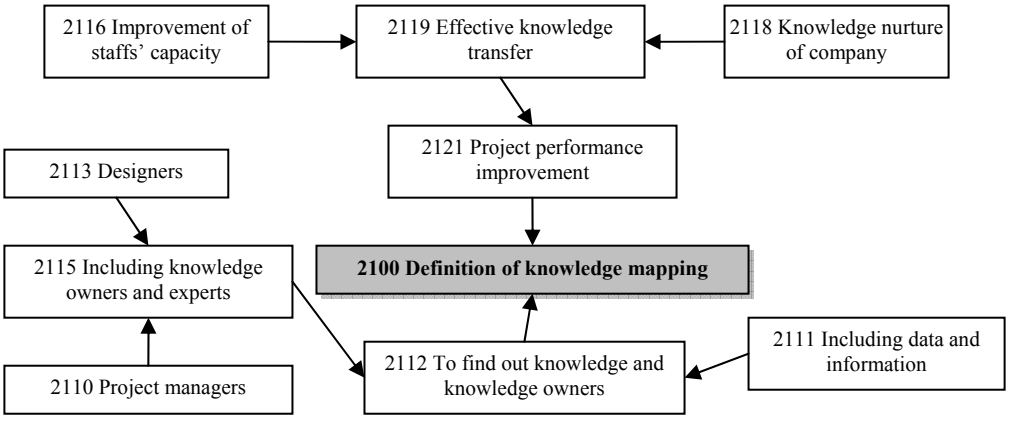


Figure 5.4 A cognitive map of project manager KIK on the definition of knowledge mapping within construction project organisations

Project manager OGK has direct experience knowledge management. He emphasised that knowledge mapping (2700) is an effective tool and necessary cornerstone (2710, 2720) for human resource management (2742) and communication improvement (2730); and, for the transferring project-based knowledge (2733). Furthermore, he insisted that knowledge map can be used for effective communication improvement (2730) between construction actors and their organisations within construction projects and also, knowledge mapping (2700) can be effectively used as a key system for effective human resource management (2742) within construction project organisation. Figure 5.5 describes a cognitive map about the key insight of project manager OGK on knowledge mapping. The following quote captured project manager OGK view of knowledge mapping:

> *"I think knowledge map can be used as a key and effective tool and necessary cornerstone into knowledge management system which is very effective to find out right knowledge or knowledge owners at the right time and it is also very important to u grade, update, classify, visualise, transfer and store knowledge in projects and organisations. Furthermore, with an appropriate knowledge map, staffs and members can improve their knowledge and capacity after that project performance and quality may be improved, having good communications and relationships with the other construction actors."*

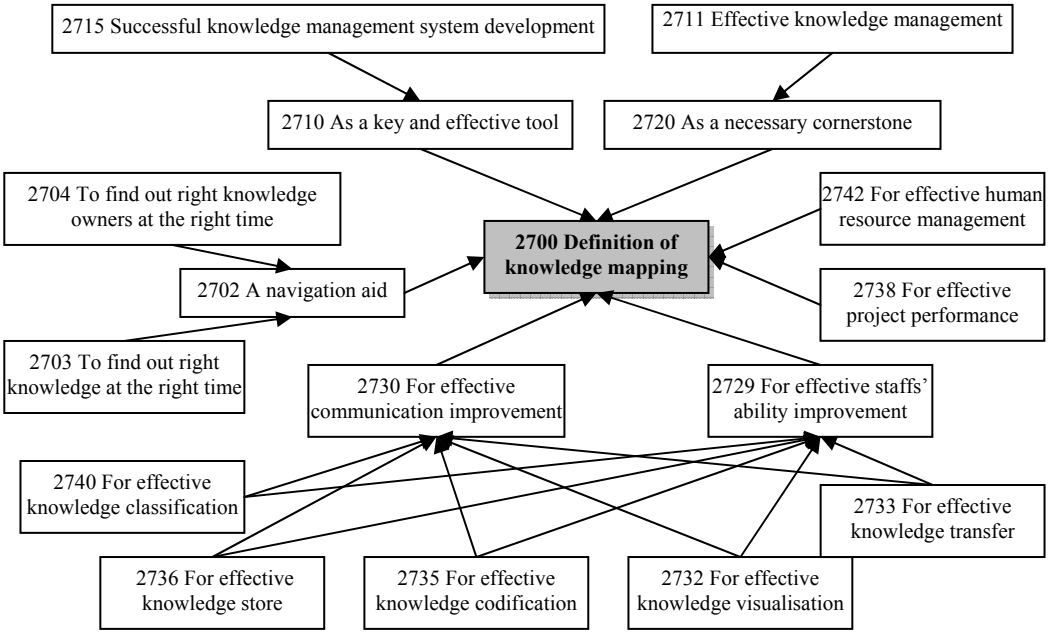


Figure 5.5 A cognitive map of project manager OGK on the definition of knowledge mapping within construction project organisations

As has been shown in Figure 5.3 – 5.5, it has been identified that the project manager interviewees recognise that knowledge map is a critical and necessary tool and component (2112, 2212, 2220, 2702, 2704, 2720 2715, 2711) for effective knowledge management (2215 2704). Project managers SSK and KIK, in particular, emphasised that knowledge mapping can be used effectively as a supporting tool to identify and find out right knowledge and contact right knowledge owners at the right time (2112, 2220, 2221) and also, is a useful process for effective knowledge classification, knowledge transfer and knowledge store (2119, 2210, 2209, 2215)

As a consequence, it can be recognised that a variety of insights were conveyed by the project managers on the key purpose and benefits of knowledge mapping on project-based organisations. Table 5.3 is synthesised the key views under the categories of "what?" and "why?"

Table 5.3 The perception of project managers on the definition of knowledge mapping within construction project organisations

	Interviewee	What? (Definition of knowledge map)	Why? (Benefits of knowledge map)
Project Manager	KIK	-A navigation aid to find out right knowledge and right knowledge owners (2112)	-Effective knowledge transfer (2119) -Effective project performance (2121) -Effective staff capability and knowledge improvement (2116) -Development of knowledge capital (2118)
	KNK	-A tool to effectively manage knowledge and knowledge owners (2112)	-Effective knowledge visualisation (2732) -Effective project performance (2121)
	SSK	-Key tool for knowledge management system development (2220, 2221) -Effective knowledge resource management (2212)	-Effective knowledge identification (2210) -Effective knowledge visualisation (2209) -Knowledge search engine development (2215)
	OGK	-A navigation aid to find out right knowledge and knowledge owners at the right time (2702, 2703, 2704) -A cornerstone to successfully develop knowledge management system (2710, 2720, 2715, 2711)	-Effective communication improvement (2730) -Effective knowledge search and knowledge owner search (2704) -Effective knowledge transfer and knowledge store (2733) -Effective project performance (2738) -Effective staffs' ability improvement (2729) -Human resource management (2742)

General perception of project members on definition of knowledge mapping

Compared with the project managers, half of the project members did not have experience with knowledge mapping within construction projects or organisations. The following Figure 5.6 - 5.8 are the cognitive maps of each of the project members on the definition of knowledge mapping.

Project member WKC stressed that knowledge maps (2300) provide a useful "picture" (2319) and was a key knowledge searching tool (2121, 2322), as well as a place where knowledge can be effectively stored and used (2313, 2314). Within this perspective, project member WKC described as follows that:

> *"I think that some construction workers are more important than the other construction workers because ….. This means that they have more experience, skills and knowledge. So if knowledge owned by the more important construction workers can be is managed projects can be more effectively completed in my opinion. I mean that we can more easily search and find out location of knowledge and knowledge resources, such as knowledge owners. Moreover, in my experience, I have heard*

that knowledge maps can be a key knowledge searching tool and effective picture like geographic map…for example road map for effective knowledge search in projects and businesses."

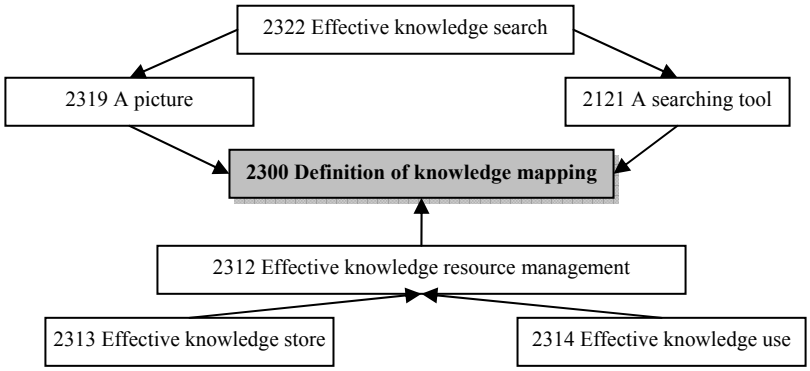


Figure 5.6 A cognitive map of project member WKC on the definition of knowledge mapping within construction project organisations

Project member KHL emphasised that knowledge mapping is an effective tool and useful supporter (2829, 2831) for successful knowledge management (2820, 2823). As a result, knowledge users, such as construction workers and end-users of the facilities, can effectively access and use project-based knowledge (2826, 2827). Project member KHL provided his view about knowledge mapping as follows:

In my experience, I firstly experienced about the knowledge management in this company. So, I know what knowledge mapping is, but do not know clearly. I am so so sorry about it. In my opinion, I think knowledge map is a key tool for knowledge users, such as construction engineers and managers like me and end-users of buildings like students, house wives and patients and also, knowledge map can be used as an effective process for knowledge or expert search system development in projects."

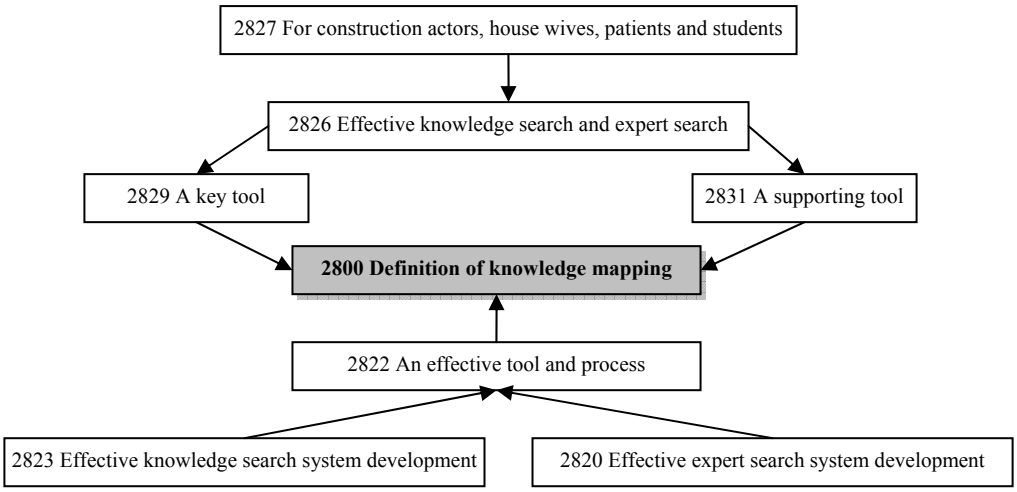


Figure 5.7 A cognitive map of project member KHL on the definition of knowledge mapping within construction project organisations

Project member JHO suggested that knowledge mapping provides necessary pictures (3129) and is a cornerstone (3122) for knowledge users and end-users of facilities (such as construction actors, students and patients (2827)), and for effective knowledge management (such as knowledge codification (3122) and knowledge visualisation (3118), successful knowledge management system development (3130)) and expert search systems and knowledge search systems (3118, 3126). Project member JHO expressed his view on this as follows:

> *"In my opinion, I think that knowledge map which is a picture and guide would be used as an effective searching tool for knowledge users. Furthermore, knowledge map which can be a cornerstone for knowledge management system development and also, can be used to effectively visualise knowledge resources."*

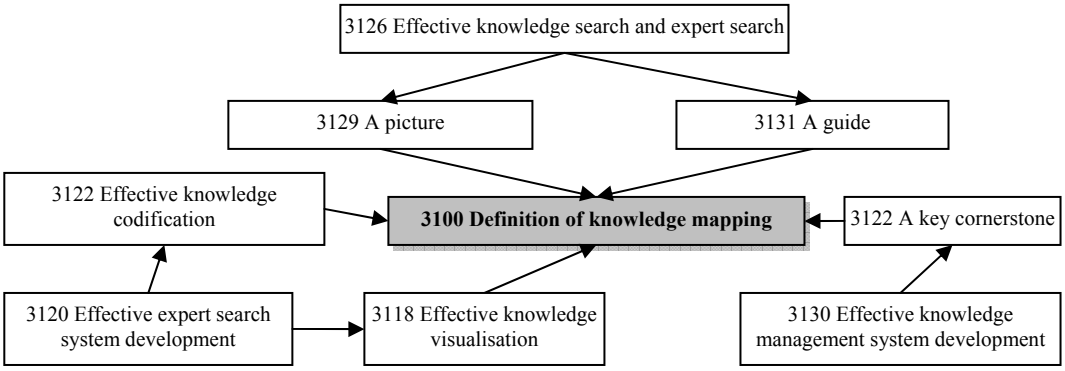


Figure 5.8 A cognitive map of project member JHO on the definition of knowledge mapping within construction project organisations

As has been shown in Figure 5.6 - 5.8, it has been confirmed that knowledge map is an effective and necessary tool and component (2121, 3131, 3129, 3122, 2831, 2822) for effective knowledge management (2312) like knowledge store (2313), knowledge use (2314), knowledge visualisation (3118) and knowledge codification (3122) and successful knowledge management system development (3130), like knowledge search system (2312, 3126) and expert search system development (3126, 2826). As a consequence, a variety of key views were conveyed by the project members on the key purpose and benefits of knowledge mapping on project-based organisations. Table 5.4 is synthesised the key views under the categories of "what?" and "why?"

Table 5.4 A synthesis of the general perception of project members on the definition of knowledge mapping

	Interviewee	What? (Definition of knowledge map)	Why? (Benefits of knowledge map)
Project Member	JHO	-A picture (3129) -A cornerstone (3122)	-Effective knowledge management system development (3130) -Effective knowledge search engine development (3126) -Effective expert search system development (3126) -Effective knowledge visualisation (3118) -Effective knowledge codification (3122)
	WKC	-A picture (2319)	-Effective knowledge use (2314) -Effective knowledge store (2313) -Effective knowledge search and management (2312)
	KHL	-A key process (2822) -A key tool (2831) -A supporting tool (2829)	-Effective knowledge search system development (2826) -Effective expert search system development (2826)

General perception of knowledge managers on the definition of knowledge mapping

The following Figure 5.9 - 5.10 are the cognitive maps of each of the knowledge managers TWK and EJP on the definition of knowledge mapping.

Figure 5.9 presents the cognitive map analysed for knowledge mapping. Knowledge manager TWK observes that appropriate knowledge mapping can support and contribute to effective knowledge management (3224) and knowledge transfer (3217). In addition, knowledge mapping can build that capability and knowledge of organisation members (3209, 3210) and improve project performance and quality (3240, 3241). Knowledge manager TWK expressed his view about knowledge mapping as follows:

> *"In my experience, I think that knowledge mapping is a key tool and basic component to effectively build knowledge management. Within this perspective, it can be guessed that knowledge mapping is effective and useful to search and find out right knowledge and knowledge owners. Furthermore, knowledge transfer and knowledge dissemination can be more effective. As a result, knowledge and capability of staff may be improved and project quality and performance may be improved."*

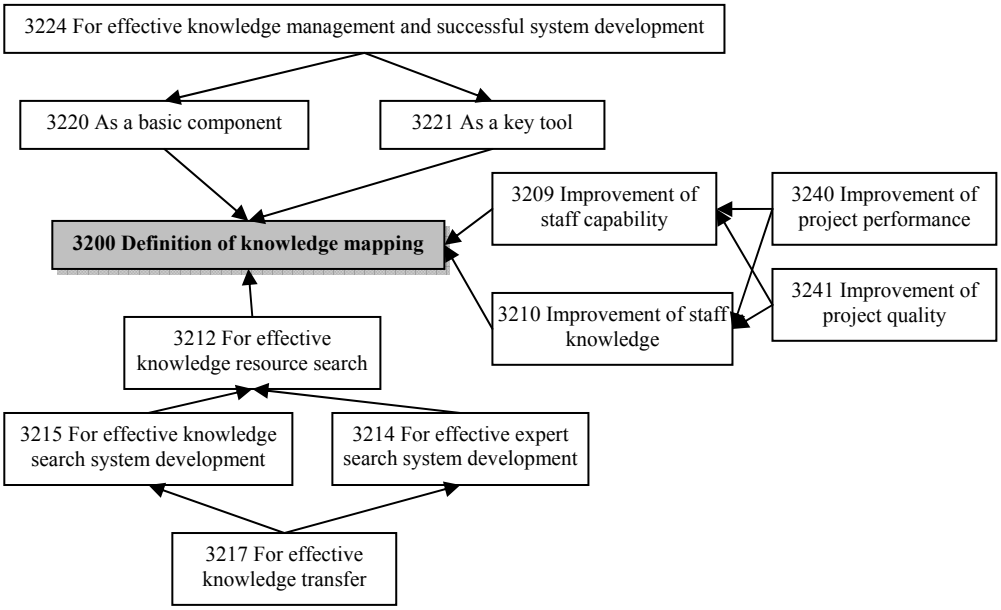


Figure 5.9 A cognitive map of project member TWK on the definition of knowledge mapping within construction project organisations

Knowledge mapping is a key tool and process (3380, 3381) for successful knowledge management (3389), in which knowledge resources and knowledge flows can be visualised (3309, 3314). Within this context, it was observed by knowledge manager JEP that:

> *"In my opinion, I think that if construction workers have problems related to his/her tasks and role in projects they would need knowledge, data and information in order to effectively solve the problems. So, if knowledge mapping can provide any important knowledge or knowledge owners to the construction workers the knowledge map is very useful and effective for effective problem-solving in projects."*

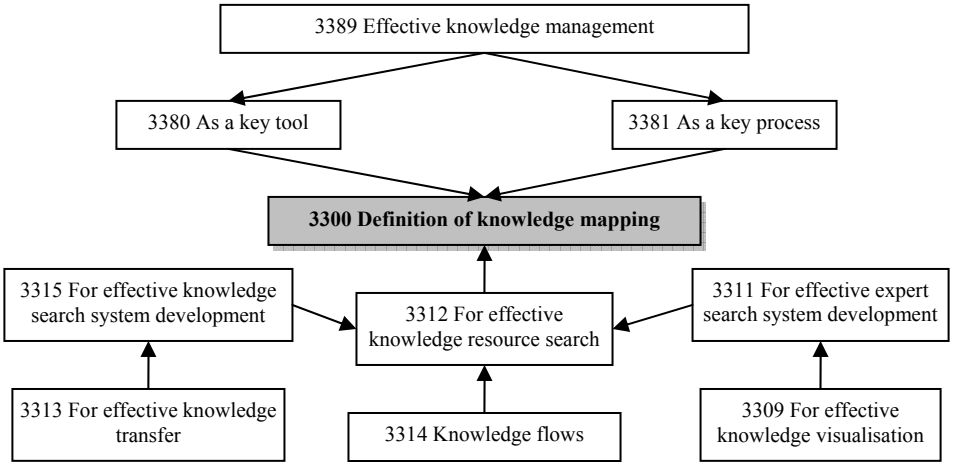


Figure 5.10 A cognitive map of project member EJP on the definition of knowledge mapping within construction project organisations

As has been shown in Figure 5.9 - 5.10, it has been confirmed that knowledge mapping is a key and necessary tool (3220, 3221, 3381, 3380) for effective knowledge management and successful knowledge management system development (3224, 3315, 3311, 3389).

As a consequence, a variety of key views of knowledge managers TWK and JEP were provided on the key purpose and benefits of knowledge mapping on project-based organisations. Table 5.5 is synthesised the key views under the categories of "what?" and "why?"

Table 5.5 Key concepts captured on the general perception of knowledge managers concerning the knowledge mapping within construction project organisations

	Interviewee	What? (Definition of knowledge map)	Why? (Benefits of knowledge map)
Knowledge Managers	TWK	-A basic component (3220) -A key tool (3221)	-For effective knowledge management and successful knowledge management system development (3224) -For effective knowledge transfer and disseminations (3217, 3218) -Effective project performance improvement (3240) -Effective project quality improvement (3241) -Effective staffs' ability improvement (3209) -Effective staffs' knowledge improvement (3210)
	JEP	-A necessary process (3381) -A critical tool (3380)	-For effective knowledge management and successful knowledge management system development (3315, 3311, 3389) -For effective knowledge transfer and visualisation (3313, 3309)

Synthesised definition knowledge mapping

Different aspects of knowledge mapping were highlighted by each group of interviewees: knowledge managers' group, project managers' group and project members' group. There was strong consensus that knowledge mapping is a key tool and cornerstone for effective knowledge management.

Moreover, it has been emphasised that through knowledge mapping, construction project performance can be improved, and the capacity and skills of construction actors can be enhanced. The following synthesised definition of knowledge mapping based on the interviews insights is offered:

> ***"Knowledge mapping is a key element of knowledge management within construction project organisations which improves project performance and human capital through the identification and learning of bodies of relevant knowledge within a structured environment which promotes appropriate knowledge search, transfer and use"***

5.3.2.2 Perception on the knowledge map model components

5.3.2.2.1 Interaction environment

Temporary project organisation was taken to the interaction environment in this study (Section 3.2). The critical importance of effective knowledge transfer within and across the temporary project organisations was emphasised (Section 2.2).

Within this context, project manager KNK, for example, noted that:

> *"Almost all construction workers like me want to share knowledge including data and information in construction project organisation. Therefore, if construction knowledge can more easily and quickly share or acquire by construction workers construction may be effectively solved and construction risks are in construction projects and organisations. I mean that knowledge sharing is very important. In addition, in my case, I have seen many construction actors who have used some technologies in order to effectively share their knowledge for effective performance of their tasks and roles within construction project organisations."*

There was strong consensus that project-based knowledge, including individual and organisational knowledge, is transferred through the temporary project organisation, using a variety of knowledge transfer technologies. Project member HWJ, for example, stressed that:

> *"In projects, I have used some technologies in order to transfer knowledge, data and information, such as e-mail systems, mobile phone and personal digital assistant (PDA). As a result of, my works and tasks in the project organisation could be successfully performed with effective knowledge share with my friends and peers. Therefore, I think that construction project organisations surely need to share knowledge, data and information for successful projects or tasks ….and construction works."*

Furthermore, as has been mentioned in Section 2.2, the key characteristics of project organisations were emphasised by the interviewees in particular concerning temporary and one-off project organisation. Knowledge manager TWK, for example, remarked that:

"In the construction industry, all construction project organisations have been always temporarily organised and after that, almost all the project organisations have been generally dissolved for next projects. In addition, in the project organisations, knowledge is shared between construction workers and their teams in order to successfully perform and manage construction works and tasks in projects, such as construction management teams."

Synthesis of the insights of the interviewees on the interaction environment

All the interviewees recognised concerning the specific environment of temporary construction project organisations where construction actors use a variety of knowledge transfer technologies in order to effectively transfer project-based knowledge. The following synthesised definition of interaction environment "construction project organisations" is given:

"Temporary construction project organisations require project-based knowledge to effectively perform projects where knowledge transfer technologies are used the project-based knowledge to effectively transfer between construction actors and their teams in order to deliver successful projects to clients."

5.3.2.2.2 Project-based knowledge

Project-based knowledge (1300) was emphasised as key being to effective project performance improvement (1305) and successful project completion (1306). It was stressed by the interviewee project managers that project-based knowledge took the form of both explicit knowledge (1302) and tacit knowledge (1301) and both types of knowledge were also complementary to each other (1304). The following representative cognitive map presents the insights of project manager KNK on the project-based knowledge within construction project organisations.

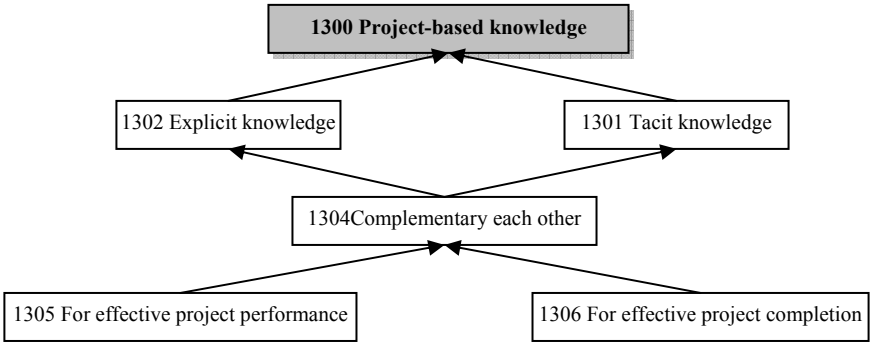


Figure 5.11 A cognitive map of project manager KNK on the project-based knowledge

Furthermore, it was noted that project-based knowledge (1400) is a type of construction-based knowledge owned and used by construction actors and construction project organisations (1401, 1403) and that project-based knowledge took key elements, such as construction actors, construction materials, construction processes, management systems, construction equipments and construction works. Figure 5.12 presents a cognitive map of the insights of the interviewee knowledge manager TWK on project-based knowledge. Knowledge manager TWK, for example, noted that:

> *"I think that there are a lot of types of knowledge in construction. Something can be easily get, access and….explained and…transferred and used, but some knowledge can not be easily codified and transferred and used …for example…ururur…. Some types of knowledge like construction procedures, construction drawings, specifications and guide books are easy to use...store…transfer. On the other hand, some specific knowledge…I mean like more individual knowledge, such as skills, know-how, insights and experiences, ..difficult to use, codify and share……"*

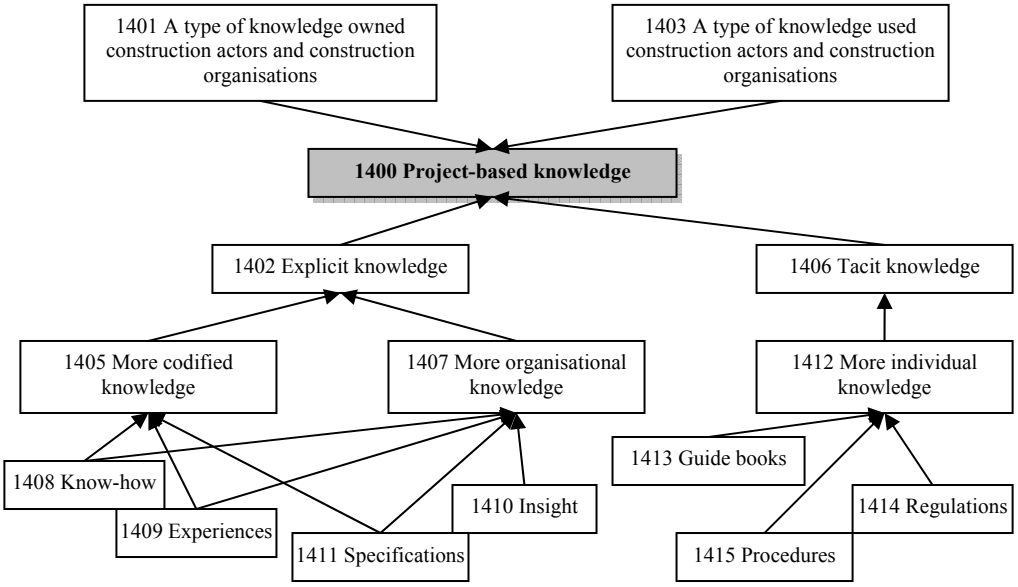


Figure 5.12 A cognitive map of the interviewee knowledge manager TWK on the project-based knowledge within construction project organisations

In particular, it has been asserted that project-based knowledge (1500) must be classified into appropriate categories to facilitate relevance and use (1510, 1512, 1513, 1518). Within this context, knowledge manager TWK and project manager KNK and OGK identified construction management-based knowledge (1504), construction work-based knowledge (1506), and construction equipment-based knowledge (1507). Figure 5.13 is to present the insights of the interviewee project manager OGK on the project-based knowledge. Project manager OGK, for example, argued that:

> *"I think the project-based knowledge is owned and accumulated by project members and their organisations…and their brain. …for example …like experiences, know-how, skills… skills? I am not sure … Also, it is very difficult to codify, transfer and store. Well….project-based knowledge is that…..it is a little bit difficult to explain, but I know about it… . Ok!. I think that is totally related to construction projects,*

engineers and tasks. The knowledge should be divided into construction management system-based knowledge, construction work and technique-based knowledge, and construction equipment-based knowledge for effective knowledge management."

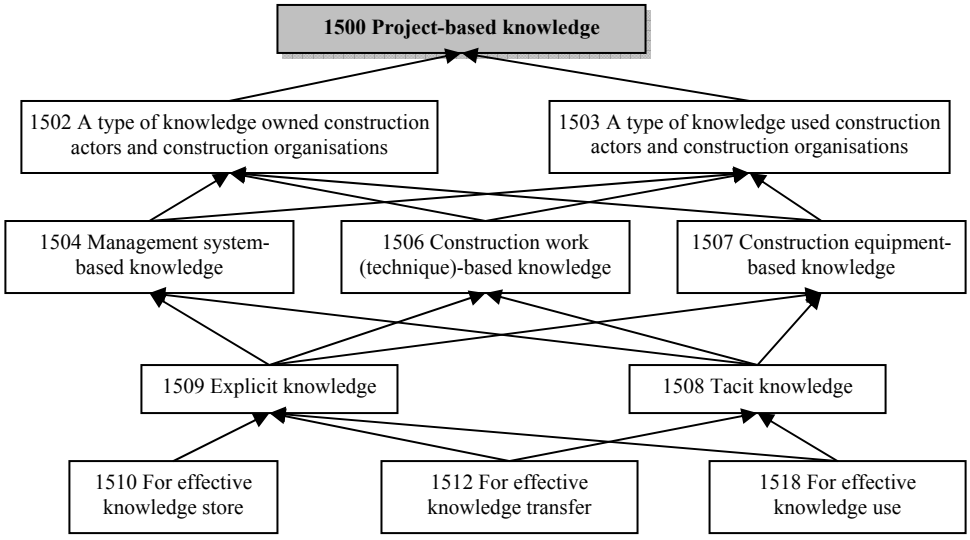


Figure 5.13 A cognitive map of the interviewee project manager OGK on the project-based knowledge within construction project organisations

Synthesis of the insights of the interviewees on the project-based knowledge within construction project organisations

Figure 5.11 - 5.13 present each cognitive map of the interviewees on the issues of project-based knowledge. The interviewees generally recognised that project-based knowledge (1500) is owned and used by construction actors and construction project organisations (1502, 1503).

In order to effectively use and transfer project-based knowledge in projects and organisations, it has been emphasised that project-based knowledge must be appropriately classified for effective knowledge management (1510, 1511, 1512, 1518): construction management system-based knowledge (1504), construction

technique-based knowledge (1506) and construction equipment (technology)-based knowledge (1507). Table 5.6 presents a summary of the key issues about the project-based knowledge. Based on the insights of the interviewees, the following synthesised definition of project-based knowledge is offered:

> ***"Project-based knowledge is owned and used by construction actors and their organisations which must be appropriately classified: management system-based knowledge, construction technique-based knowledge, and construction equipment-based knowledge.***"

Table 5.6 A summary of the insights of the interviewees on the project-based knowledge within construction project organisations

	What	Why	The type and shape of knowledge		
Project-based knowledge	A type of knowledge owned and used by construction actors and construction organisations (1401, 1403)	For effective project performance (1305) For effective project completion (1306)	Construction management system-based knowledge (1504)	Explicit Knowledge (1302, 1402, 1509)	Guide books (1413), procedures (1415), laws, regulations (1414), construction drawings, specifications
				Tacit knowledge (1301, 1406, 1508)	Experiences (1409), insights (1410), skills, know-how (1408), techniques, intuitions
			Construction work (technique)-based knowledge (1506)	Explicit knowledge (1302, 1402, 1509)	Guide books (1413), procedures (1415), laws, regulations (1414), construction drawings, specifications
				Tacit knowledge (1301, 1406, 1508)	Experiences (1409), insights (1410), skills, know-how (1408), techniques, intuitions
			Construction equipment-based knowledge (1507)	Explicit Knowledge (1302, 1402, 1509)	Guide books (1413), procedures (1415), laws, regulations (1414), construction drawings, specifications
				Tacit knowledge (1301, 1406, 1508)	Experiences (1409), insights (1410), skills, know-how (1408), techniques, intuitions

5.3.2.2.3 Construction actors

The role of construction actors as a key project-based knowledge owner and user within temporary construction project organisation was discussed in Section 2.2.3 and Section 3.2.3.

Within this regard, the interviewees were asked to provide their insights concerning the role of construction actors within the knowledge mapping approach within construction project organisations. All the interviewees noted that construction actors must be explicitly considered as a key component of the

knowledge mapping. In particular, it has been highlighted by 10 in the interviewees that the scope of construction actors must be carefully defined for an effective and appropriate knowledge mapping within construction project organisation. This was, for example, insisted by the interviewee project member JHO as follows:

> *"I think that the scope of construction actors should be considered and limited for effective and successful knowledge mapping because too many construction actors exist and work in project…… In projects, too much knowledge is generated and used… stored in the knowledge management system of our company, but it is big problem that knowledge search engine and expert search engine is ineffective and inefficient. To be honest, in the knowledge management system of our company, knowledge has just been stored and accumulated without effectively sorting out and organising. That is a big problem. In my experience, I strongly believe that considering too many construction actors to knowledge mapping is definitely ineffective."*

As has been stated above, it can be said that defining the scope of appropriate construction actors early on in the knowledge mapping process is a key part of successful knowledge map development within construction project organisation. In the interviews, two of the interviewees (knowledge manager JEP and project member WKC) asserted that all the construction actors (1602) are equally important. They must be considered in the knowledge mapping process because all the construction actors have got their own specific roles and tasks (1605) and they also have their own unique project-based knowledge which is essential to the completion of their roles (1604). Figure 5.14 presents the key results of the project member WKC on the construction actors. Project member WKC confirmed that:

> *"In order to successfully complete projects, I think that all the construction actors are important and necessary because they have their*

own specific roles and works in organisations and projects. In other words, I believe that all of the construction actors must be considered as a key component of knowledge mapping because construction projects consist of a variety and number of construction phases and sub-processes which can be always implemented by all the construction workers, but they can never ever be completed by only specific construction workers. Therefore, I think all of the construction workers must be equally considered and applied for successful knowledge mapping within construction projects and construction organisations."

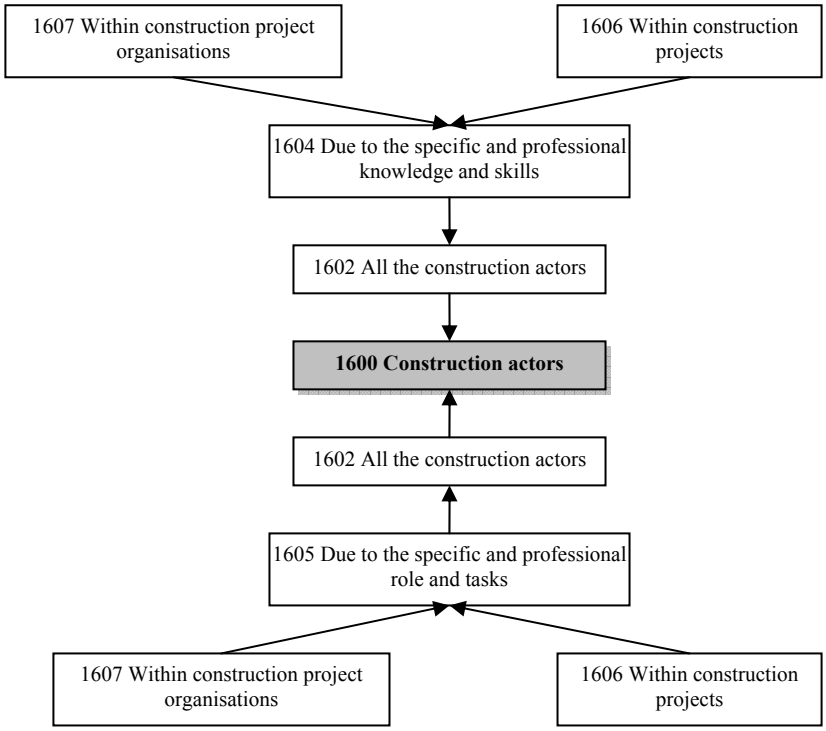


Figure 5.14 A cognitive map of the interviewee project member WKC on the construction actors within the knowledge mapping

On the other hand, 10 in the 12 interviewees observed that specific construction actors (1702), such as project managers, designers, inspectors, quantity surveyors,

construction managers and site supervisors (1720), must be prioritised in the knowledge mapping approach because the construction actors (1700) have more critical roles and tasks (1711). Furthermore, they have core knowledge and capabilities (1701) in construction project organisations (1709), compared to other construction actors.

From this perspective, the interviewee project manager KNK, for example, argued that some key decision makers and core managers (1702, 1703), such as clients, project managers, architects and quantity surveyors(1720), are more valuable in construction projects (1708). Figure 5.15 is to present the key insights of project manager OGK and knowledge manager TWK on the construction actors. Within this context, project manager OGK confirmed as follows:

> *"I think that clients and some decision makers like project managers, site supervisors and architects… are more important than the other construction workers because they can perform any important cases or decisions in the key construction project situation. Moreover, they have got some core responsibilities and authorities to surely make some decisions and successfully solve some problems related their tasks in construction project. Therefore, some decision makers are more important."*

Knowledge manager TWK stressed that:

> *"I think it is on the effectiveness. So, who are the effective professionals for construction project? May be some experts like project managers, architects, QS, site managers, clients…..could be…..I mean the people who have good knowledge, such as know-how, experiences and skills, insights and…… the other high level knowledge about construction processes and construction technologies……because almost all construction workers are managed and deployed by some specific*

construction professionals…for example, they manage and organise project teams and construction processes and they can decide some core issues in projects and businesses. Also, they have a variety and lot of knowledge, like know-how, experience, insights related to project performance and management."

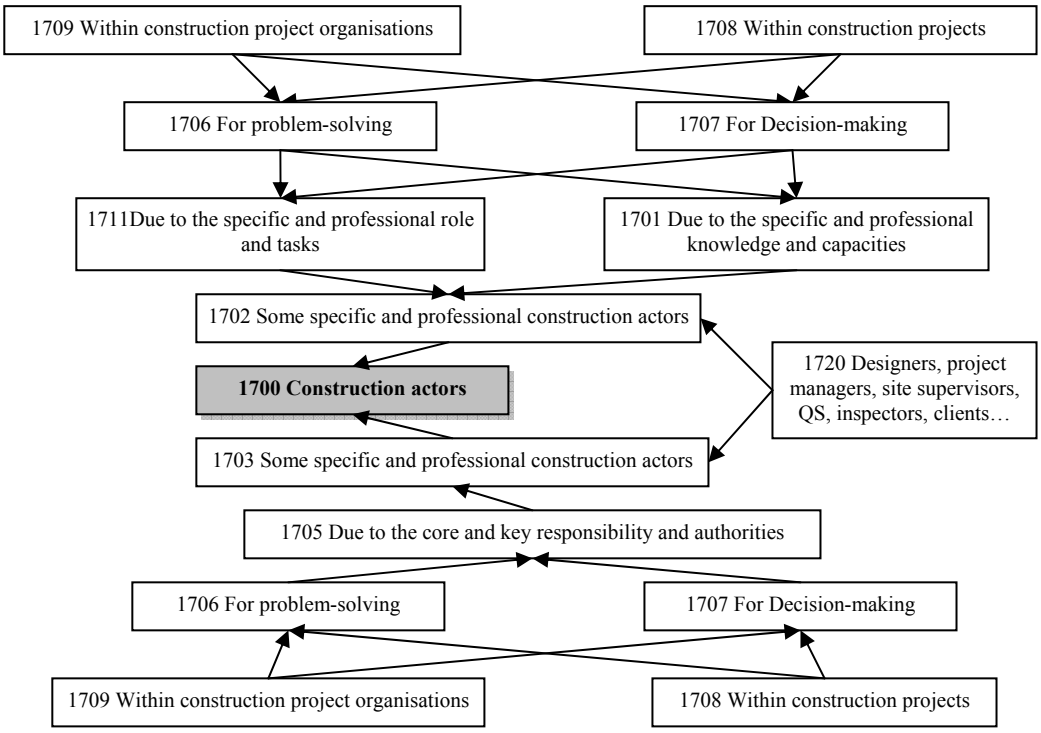


Figure 5.15 A cognitive map of the interviewee project manager OGK and knowledge TWK on the construction actors

Synthesising the insights of the interviewees on the construction actors as a key knowledge map model component

Figure 5.14 - 5.15 present the key insights of the interviewees about role of the construction actors in project organisations and knowledge mapping. Table 5.7 is a summary of the key issues about the role of the construction actors. Based on the insights gained from the research case study data, the following synthesised definition of the role of construction actors is offered as follows:.

"Construction actors are a key construction project component: both as key project performers and as critical project-based knowledge owners and users within construction projects and construction project organisations. Therefore, construction actors must be considered as a critical part of knowledge mapping approach, classifying into strategic construction actors and operational construction actors."

Table 5.7 A summary of the key insights of the interviewees on the construction actors proposed as a knowledge map model component

	Scope	Who (Actors)	Why (Need)
As a key knowledge mapping component	All the construction actors (1602)	All the construction actors including clients, end-users and contractors…	-The specific and traditional knowledge and skills owned by each construction actor (1604) -The specific and traditional role and tasks assigned to each construction actor in construction projects and organisations (1605)
	Specific construction actors (1703)	Project managers, construction managers, Quantity surveyors, site supervisors, site managers, inspectors, lawyers, architects, clients…..	-More specific, core and professional knowledge and capacities owned used by the construction actors (1701) -More specific and key role and tasks in construction projects and organisations (1711) -More key responsibilities and authorities as a decision maker and manager in construction projects and organisations (1705)

5.3.2.2.4 Construction processes

Construction processes are a key component of effective project performance (Section 2.2). Within this context, eleven of the interviewees agreed that construction projects are delivered through various processes (2100, 2002) by different construction actors (2001). Furthermore, construction processes confirmed as a key unit for effective project performance (2007) and construction management (2006). Figure 5.16 is a cognitive map of the interviewee knowledge manager JEP on the value of construction processes.

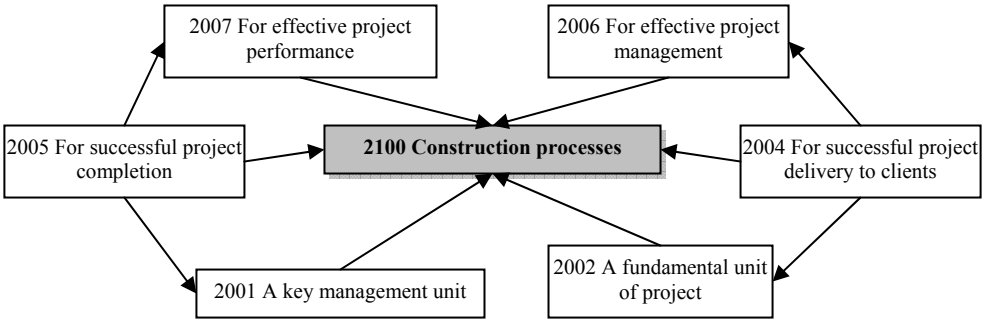


Figure 5.16 A cognitive map on the value of construction processes as a key project component

All the interviewees noted that construction processes must be explicitly considered as a key component of an appropriate knowledge mapping approach. In particular, four of the interviewees (project manager OGK and KNK, project member HSC and knowledge manager TWK) insisted that construction processes at the pre-construction phases (2302, 2308) are more important due to greater possibility of cost reduction, time reduction and quality improvement of project (2303, 2305, 2307). The interviewees also stressed that effective knowledge maps are based on a limited application of key construction project resources. Project member HSC (see cognitive map Figure 5.17), for example, articulated the role of construction processes as follows:

> *"In my experience, I believe…definitely.. that pre-construction stages like design phase are recognised…..I think … as more important processes on more effective cost reduction. This means that design stage is one of more important and effective stages because of possibility of cost and time reduction and quality improvement in construction."*

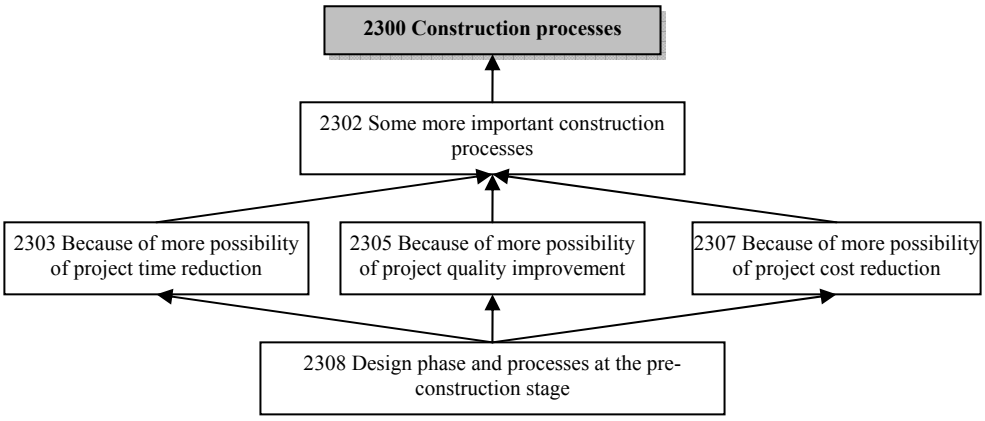


Figure 5.17 A cognitive map on the value of construction processes as a key project component

In contrast, the other eight of the interviewees asserted that all the construction processes must be considered within knowledge maps. Within this context, project manager KIK, for example, noted that all the construction processes (2501) must be captured in knowledge maps because construction projects are made up of a conglomeration of construction processes (2506, 2507) and also, construction projects are delivered to clients (2004).

All the interviewees emphasised that construction processes (2500) must be classified into two groups for knowledge mapping: construction management system-based processes (2502); and, construction work-based processes (2505). Furthermore, these groups need to be in accordance with each project type (2507), such as official buildings, commercial buildings, industrial facilities, education/cultural facilities, sports facilities and high rise building. Within this context, project manager KIK confirmed as follows (see cognitive map Figure 5.18):

> *"I think the most important point is that construction processes must really be divided into two parts. I mean … for example, into construction work processes and construction management processes because maybe……..you know management systems, such as cost management, quality management, time management and the other management systems, are not involved in construction work processes. I think management system processes are totally different part as compared with construction work processes."*

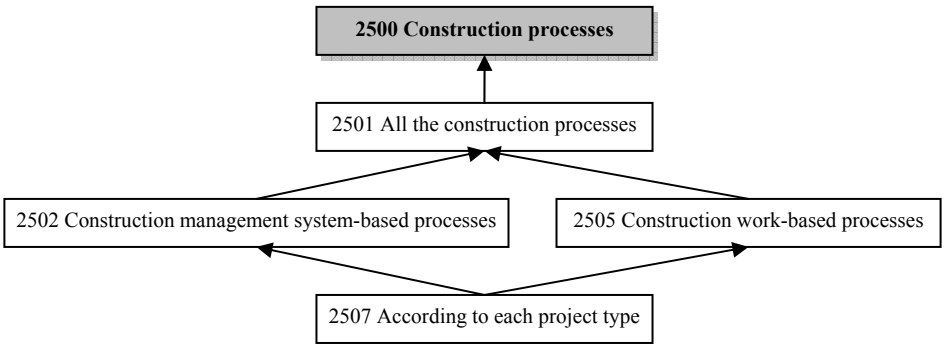


Figure 5.18 A cognitive map on the value of construction processes as a key project component

Synthesising the key insights of the interviewees on the value of construction processes as a key knowledge map model component

Construction processes must be considered as a key knowledge map concept model component. However, there are a number of different opinions concerning the processes as to whether knowledge map should be built around a limited number of core processes or that they should capture all of the processes used. There was consensus that the processes should be classified into construction management system-based processes and construction work-based processes.

Table 5.8 is to summarise the key insights of the interviewees on the value of construction processes as a key knowledge map concept model component within construction project organisation. The research findings lead to the following synthesised definition of construction processes as a key knowledge map component:

> ***"Construction processes are a key construction project component: as a fundamental and necessary unit for project performance within construction projects and construction project organisations. Within this context, construction processes are managed to reduce project cost and project time and to improve project quality by construction actors. Therefore, construction processes must be considered as a critical part of knowledge mapping approach, classifying into general management***

system-based processes and construction work-based processes."

Table 5.8 A summary of the key insights of the interviewees on the construction processes proposed as a key knowledge map model component

	What	Why (Need)	Type	
Construction processes	Project is a conglomeration and continuum of processes (2001, 2002, 2506, 2507) A key and fundamental unit for effective project performance and project management (2001, 2002)	Due to more possibility of project cost reduction (2307) Due to more possibility of project time reduction (2303) Due to more possibility of project quality improvement (2305)	All the construction processes (2501)	Construction management system-based processes (2502) Construction work-based processes (2505)
		Due to specific characteristics of construction project as a continuum and sequence of processes (2001, 2002)	Some more important construction processes at the pre-construction stages (2302, 2304)	Design phase and processes (2308)

5.3.2.2.5 Knowledge transfer technologies

Section 2.2.6 has argued that technologies are essential for effective knowledge management tasks, including knowledge classification, knowledge codification, knowledge store, knowledge dissemination and knowledge transfer within and across individuals and organisations in projects.

All the interviewees confirmed that construction actors utilise a variety of technologies to effectively transfer project-based knowledge including data and information within and across construction project organisations. Project manager OGK, for example, noted that project-based knowledge can be effectively transferred (2703) between organisation members and their teams by knowledge transfer technologies, for example question and answer system, mobile phone, e-mail system and MSN messenger system. Knowledge manager TWK (see cognitive map Figure 5.19) stresses that:

> *"In projects, almost all the construction workers, for example……site managers or project managers…like architects are used to face many construction problems…. and then, although they do not have right knowledge to effectively solve the problems if they can more easily and*

quickly access or gain the right knowledge …I think that the problems may be more effectively solved. This is my opinion…I think that is good…is not it! You know…I mean that technologies are very important as knowledge transfer tools within projects or organisations."

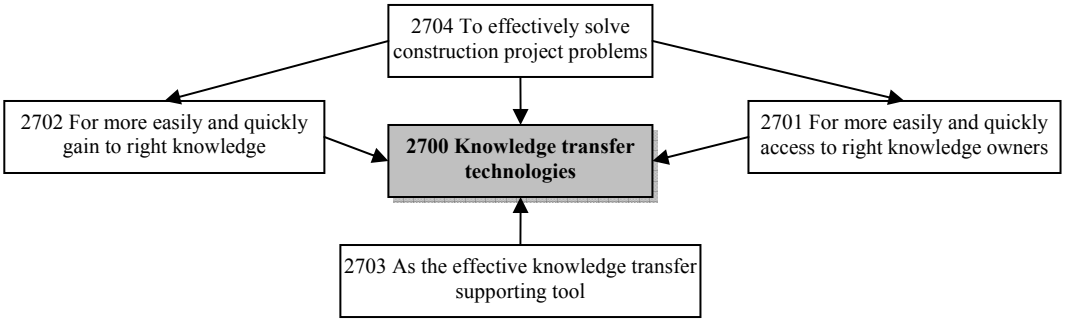


Figure 5.19 A cognitive map on the value of knowledge transfer technologies as a key knowledge transfer supporting tool within construction project organisations

A variety of knowledge transfer technologies were identified (2600) in the interviews. Project member WKC and knowledge manager TWK, for example, remarked that some specific technologies (2608, 2609, 2610), such as question and answer systems (2614), personal digital assistants (2610), mobile phones (2611), knowledge management systems (KMS), e-mail systems (2613) and MSN messenger systems (2618), are used for effective knowledge transfer (2601) between construction workers and their teams within and across construction project organisations. Project managers KNK and SSK and project members HWJ and WKC emphasised that knowledge transfer technologies can effectively improve communications between individuals and organisations within projects. Project manager KNK (see cognitive map Figure 5.20) conveyed the role of knowledge transfer technologies as follows:

"In my case, I have used some technologies in order to effectively

transfer my own knowledge including data and information to the others, such as knowledge management system, mobile phone, the internet, e-mail and MSN. That is all. Actually, I think…project performance of course…my knowledge and ability is improved and increased with easier knowledge transfer within projects……. Above all the things, I think that mobile technology systems like mobile phone and PDA you know blackberry which is a type of mobile phone were more useful to effectively transfer knowledge in projects and organisations in the form of pictures, moving pictures and text on the real time."

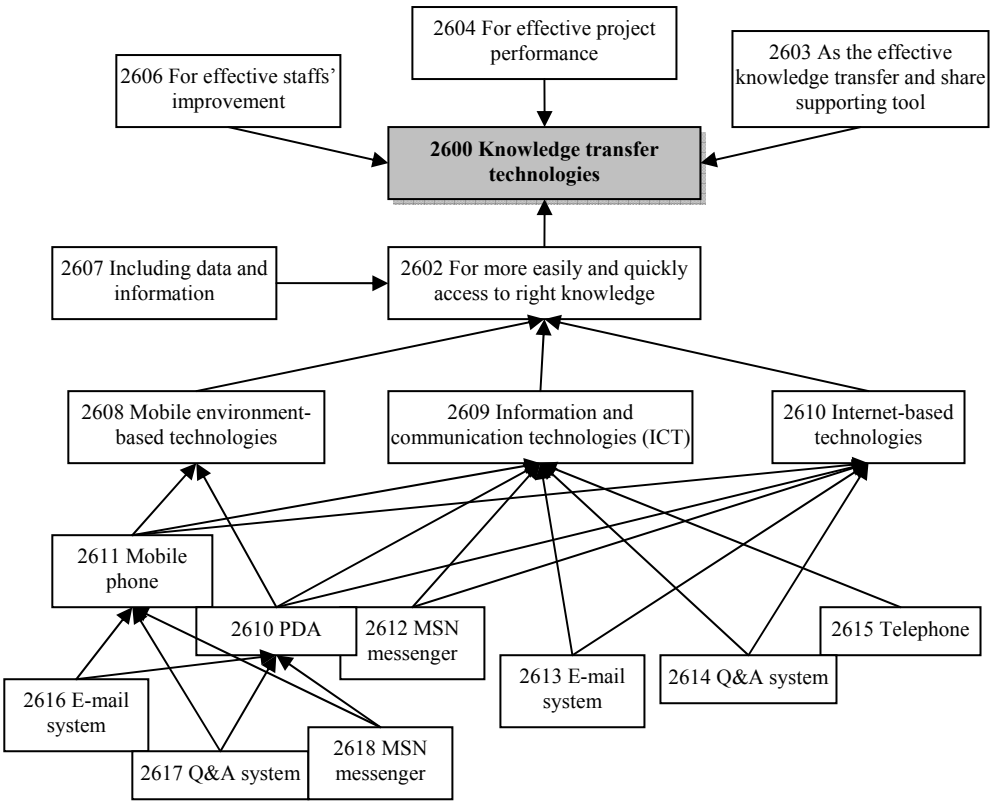


Figure 5.20 A cognitive map on the value of knowledge transfer technologies as a key knowledge transfer supporting tool within construction project organisation

As has been seen in Figure 5.20, a variety of knowledge transfer technologies

have been utilised for effective knowledge transfer (2603, 3101, 3102); for effective project performance (2604); and, project-based learning (2606) by construction actors within construction project organisation. From this perspective, project managers KIK and OGK, knowledge manager TWK and project members KTK and HSC observed that technologies are utilised according to the type of knowledge (3108, 3109). Tacit knowledge (3108) can be, for example, more transferred by some specific knowledge transfer technologies, such as telephone (3115), personal digital assistant (3110) and mobile phone (3111). Project member HSC (see cognitive map Figure 5.21) conveyed the role of knowledge transfer technologies as follows:

> *"I think that we need to more quickly contact to construction professionals. I mean core experts…. because to gain good tacit knowledge as directly as possible, such as know-how, experiences and techniques. It may be the most ..,more effective to gain tacit knowledge in projects and organisations……with telephone, mobile phone, PDA….radio……with talking about knowledge owners. I think so…that some technologies like e-mail, knowledge management system and the internet have been also used and will be used to transfer explicit knowledge, such as procedures, guide books, data, drawings and specifications……."*

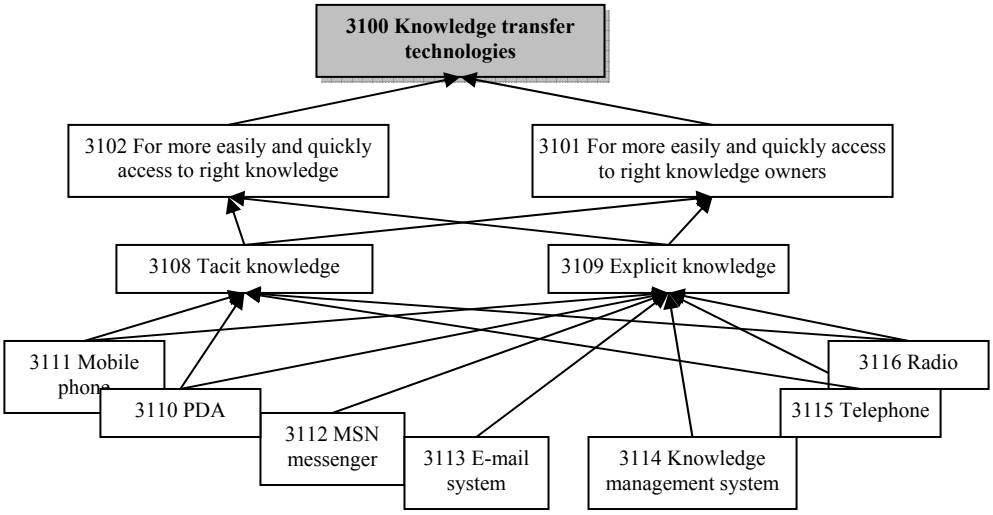


Figure 5.21 A cognitive map of project member HSC on the value of knowledge transfer technologies within construction project organisation

Nine of the interviewees noted that mobile technology systems and mobile computing systems may be more effective for project-based knowledge transfer within projects and organisations. Within this context, knowledge manager TWK and project manager KIK, in particular, stressed that construction workers need to use mobile technologies to more easily and quickly access (3501, 3502) to the right knowledge at the right time and to effectively transfer project-based knowledge. This includes data and information (3505) between construction actors within and across construction project organisations.

Furthermore, knowledge manager KTW and project managers OGK and KNK stressed that specific knowledge transfer are utilised for effective knowledge transfer between construction actors and their teams, such as mobile computing system, mobile phone (3511) and personal digital assistant (3510) installed Wibro (Wireless Broadband Internet) (3520), RFID (Radio Frequency Identification) (3522), digital camera (3524) and voice recorder (3523). The following Figure 5.22 is a cognitive map of the insights of the interviewees concerning the knowledge transfer technologies used and available within construction project

organisation.

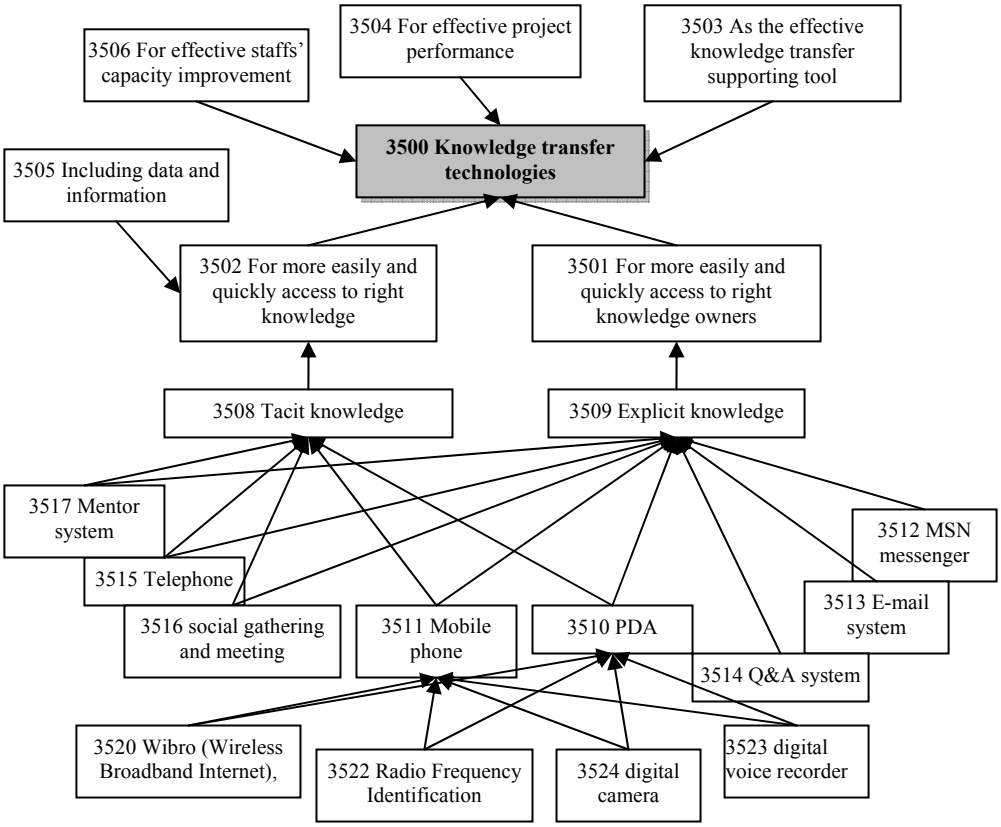


Figure 5.22 A cognitive map of the perception and insights of the interviewees on the knowledge transfer technologies used and available within construction project organisation

Synthesising the key insights of the interviewees on the knowledge transfer technologies

Figures 5.19 – 5.22 presented individual cognitive maps on the project-based knowledge transfer technologies used within construction project organisation. Table 5.9 presents a summary of the key on the value of knowledge transfer technologies. The research findings lead to the following synthesised definition of knowledge transfer technologies:

"Knowledge transfer technologies are a key knowledge management component: as a strategic factor for knowledge transfer within construction projects and construction project organisations. Knowledge transfer technologies are useful to effectively transfer construction project-based knowledge including data and information between construction actors and their teams within construction project organisations. In doing so, construction project performance is effectively improved; and, capability and knowledge of staff is improved. Therefore, knowledge transfer technologies must be considered as a critical part of knowledge mapping approach, classifying into both explicit knowledge transfer technologies and tacit knowledge transfer technologies."

Table 5.9 A summary of the key insights of the interviewees on the knowledge transfer technologies within construction project organisations

	What	Why	Type			Accessories
Knowledge transfer technology	-Knowledge transfer technologies are effective and critical technologies for construction project-based knowledge transfer between construction actors within and across construction project organisations	-Effective project-based knowledge transfer (2703) -Effective knowledge acquirement (2702) -Effective project performance improvement (2604) -Effective improvement of staff' knowledge and capacity (2606)	Explicit knowledge (3109)	ICT (2609)	Mobile phone (2611), Telephone (2615), Websites, Q&A system (2614), E-mail system (2613), KMS (3114), MSN (2618), PDA (2610), Radio (3116)	-Wibro (3520) -RFID (3522) -Digital camera (3524) -Digital voice recorder (3523)
				IBT (2610)	Mobile phone (2611), Websites, Q&A system (2614), E-mail system (2613), KMS (3114), MSN (2618), PDA (2610)	
				MBT (2608)	Mobile phone (2611), PDA (2610)	
				SNW	Social gathering and meeting (3516), Mentor system (3517)	-
			Tacit knowledge (3108)	ICT	Mobile phone (2611), Telephone (2615), PDA (2610), Radio (3116)	-Wibro (3520) -RFID (3522) -Digital camera (3524) -Digital voice recorder (3523
				IBT	Mobile phone (2611), PDA (2610)	
				MBT	Mobile phone (2611), PDA (2610), Radio (3116)	
				SNW	Social gathering and meeting (3516), Mentor system (3517)	-
			Both	ICT	Mobile phone (2611), Telephone (2615), Websites, Q&A system (2614), E-mail system (2613), KMS , MSN (2618), PDA (2610), Radio (3116)	-Wibro (3520) -RFID (3522) -Digital camera (3524) -Digital voice recorder (3523
				IBT	Mobile phone (2611), Websites, Q&A system (2614), E-mail system (2613), KMS (3114), MSN (2618), PDA (2610)	
				MBT	Mobile phone (2611), PDA (2610), Radio (3116)	
				SNW	Social gathering and meeting (3516), Mentor system (3517)	-

Key ICT: Information Communication Technologies IBT: Internet-based Technologies
MBT: Mobile Environment-based Technologies SNW: Social Networks
PDA: Personal Digital Assistant Wibro: Wireless Broadband Internet
RFID: Radio Frequency Identification

5.3.3 Key benefits of adoption an integrated approach to knowledge mapping

In previous sections, the research findings have strongly supported the importance of the key knowledge map model components: construction actors; construction processes; and, knowledge transfer technologies. Furthermore, the research findings stressed the importance of the components being appropriately integrated to provide an effective knowledge mapping solution. It is insufficient to develop any one of the components in isolation.

The key benefits of this integrated approach articulated by the interviewees are grouped into the construction project area and the knowledge management area.

Construction project benefits

Eleven of the interviewees noted that a variety of potential construction project benefits, including project time, project cost and project quality. Knowledge managers JEP and TWK and project manager KIK, for example, remarked that total project cost (3926) and total project time (3925) can be reduced and construction project quality (3924) can be also improved by utilising a well-developed knowledge map where construction actors, construction processes and knowledge transfer technologies are integrated.

As a result, the satisfaction of clients and end-users (3916) through project cost reduction (3926), shorter project times (3925) and project quality improvement (3924) is improved. Furthermore, the confidence and capability of construction companies (3907) can be enhanced. Within this context, project manager KIK, for example, affirmed the confidence and competitiveness of companies (3907) may be increased through improvement of company weaknesses through self-

evaluation (3905) and staff training (3909, 3910). Project manager KTK (see cognitive map Figure 5.23) describes the key benefits as follows:

> *"I think…and believe that many benefits may be derived from the knowledge mapping……First, customer service and satisfaction can be improved with the capacities and skills of organisation members improved through effective knowledge transfer within construction project organisations and also, the confidence and competitiveness of companies may be increased…and projects would be more effectively performed……knowledge improvement of me…my fellows, friends in this company….may be…that is it."*

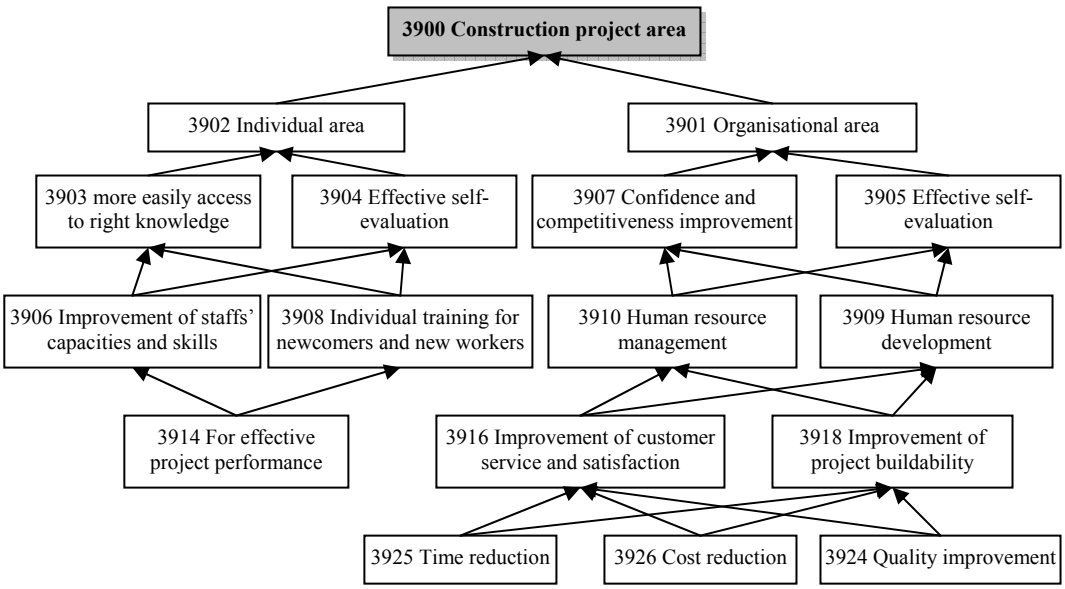


Figure 5.23 A cognitive map of the benefits on the application and integration of the key components to the knowledge mapping within construction project area

As has been seen in Figure 5.23, performance evaluation of organisation members (3904) can be more effectively performed by themselves. This means that as a

result, individual capability and knowledge for project performance can be more effectively recognised and improved by a well-developed knowledge map (3906). Project member WKC stressed that knowledge maps can be used to evaluate and enhance the competency of companies (3907) and ability of organisation members (3906). Furthermore, knowledge manager TWK, project member WKC and project manager SSK strongly argued that construction project performances can be improved (3914). Within this context, project member KTK described the key construction project benefits as follows:

> *"In my opinion, I can guess that in general, new workers and newcomers do not know about their tasks clearly although the tasks are simple. Secondly, public confidence of company can be improved and increased… and ability of staffs and competency of company can be increased and improved…….… So, I can say knowledge transfer technologies would be needed for effective knowledge transfer between construction actors within construction project organisations."*

Furthermore, knowledge manager TWK and project manager KIK and project members KHL and HWJ added that knowledge maps can be used for effective human resource management (HRM) (3910) and human resource development (HRD) (3909).

Knowledge management benefits

In the knowledge management area, a number of benefits of an integrated knowledge mapping approach were identified. In particular, project-based knowledge can be more effectively managed (4102) and an appropriate knowledge management system (4101) can be more successfully developed through knowledge mapping. Knowledge manager TWK (see cognitive map Figure 5.24) described the knowledge management benefits as follows:

> *"I dare insist that an appropriate knowledge map which is considered*

and developed with the key construction project components like…. construction workers, equipments, construction works, and construction processes…. It is maybe very effective and useful to manage construction-based knowledge…of course~~ for and within construction projects and teams….organisations, for example….such as knowledge classification, knowledge transfer and knowledge store and ……knowledge search system development with experts. I mean …human resource search system!"

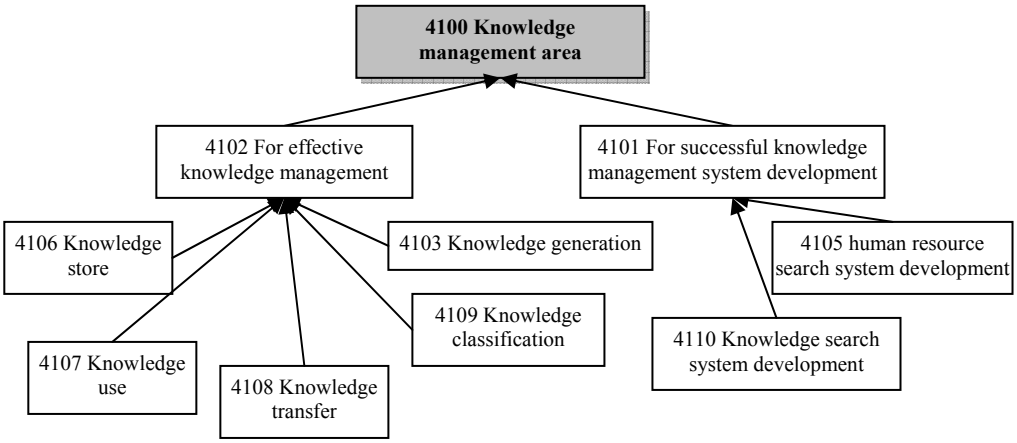


Figure 5.24 A cognitive map of the insights of the interviewee knowledge manager TWK on the benefits of integrating the key components to the knowledge mapping

As has been seen in Figure 5.24, an integrated approach to knowledge mapping has a variety of benefits for effective knowledge management (4102) and successful knowledge management system development (4101) within construction project organisations. This means that key knowledge, in particular, project-based knowledge like construction actor-based knowledge and construction process-based knowledge, can be more effectively generated (4103), transferred (4108), used (4107), classified (4109) and stored (4106). Within this context, knowledge manager JEP and project manager SSK, for example,

observed that project-based knowledge can be more effectively transferred (4108) and used (4107) within project organisations and also, construction projects may be more effectively performed. Furthermore, it has been argued that some types of knowledge management systems (4101) can be effectively developed, such as knowledge-based search system (4110) and human resource-based search system (4105). Project manager OGK expressed the key knowledge management benefits as follows:

> *"In my experiences, I have experienced …I think…knowledge mapping is vital and essential because…because….. knowledge maps are effective…to look for knowledge and experts….if it was developed very well …I think that if the location of knowledge and knowledge owners can be visually described. Construction workers like me and my peers can be more easily accessed to right knowledge in construction sites or offices during performing projects."*

Synthesising the key insights of the interviewees on the benefits of integrating the key knowledge map model components

Figure 5.23 and Section 5.24 describes individual cognitive maps on the benefits of an integrated approach to knowledge mapping. Table 5.10 summarises the key issues of the key benefits.

Table 5.10 A summary of the insights of the interviewees on the benefits of integrating the key knowledge map model components within construction project organisation

	Area	Level	Key benefits
Classification	Construction project area (3900)	Individual level (2902)	-Effective self-evaluation (3904) -Easier access to knowledge and knowledge owners (3903) -Improvement of staffs' capacity and knowledge (3906) -Effective training for newcomers and new workers (3908) -Effective project performance (3914)
		Organisational level (3901)	-Effective self-evaluation (3905) -Confidence and competitiveness improvement (3907) -Organisational human resource management (3910) -Organisational human resource development (3909) -Improvement of customer service and satisfaction (3916) -Improvement of construction project buildability (3918) -Time and cost reduction/quality improvement (3924, 3925, 3926)

	Knowledge management area (4100)	Knowledge management level (4102)	- Knowledge generation, knowledge share, knowledge store, knowledge use, knowledge transfer and knowledge classification (4103, 4106, 4107, 4108, 4109)
		Knowledge management system level (4101)	-Expert/knowledge owner-based search system development -Knowledge-based search system development (4105, 4110)

5.3.4 Major constraints to effective knowledge mapping

In order to effectively recognise, identify and remove the constraining forces and successfully develop an appropriate knowledge map within construction project organisations, the investigation of the constraints of the knowledge mapping is vital. From this perspective, the interviewees were asked to provide their insights on the constraints of the knowledge mapping within construction project organisation.

In the interviews, a number of restraints of the knowledge mapping within construction project organisation have been provided by the interviewees, such as poor organisation culture (4302) and its ineffective management, shortage of experts and poor training systems and methods (4502), poor knowledge management technologies and their ineffective development and utilisation (4505). Within this context, knowledge manager TWK, project manager OGK and project member KKC, for example, noted that poor interest (4302, 4411) of staff (4304) in knowledge sharing culture is a key restraining force for knowledge mapping within construction project organisations. Project manager OGK (see cognitive map Figure 5.25) expressed the key constraints to effective knowledge mapping as follows:

> *"In the company, poor interest in knowledge mapping is, for example, a critical constraint in the construction industry. Furthermore, in my experiences,…there are a lot of disadvantages ….on the poor knowledge management…I think this is closely related poor knowledge mapping…is not it! …I think .. that firstly, chief executive officers can hesitate to invest to knowledge map development. Within this point, poor leadership of chief executive officer is one of the most important*

restraints within construction project organisation because I think…in my cases, strong leadership of chief executive officer is a key enabling force for successful project achievement and….so…I think that may be a important factor for poor knowledge mapping…This is all my opinions."

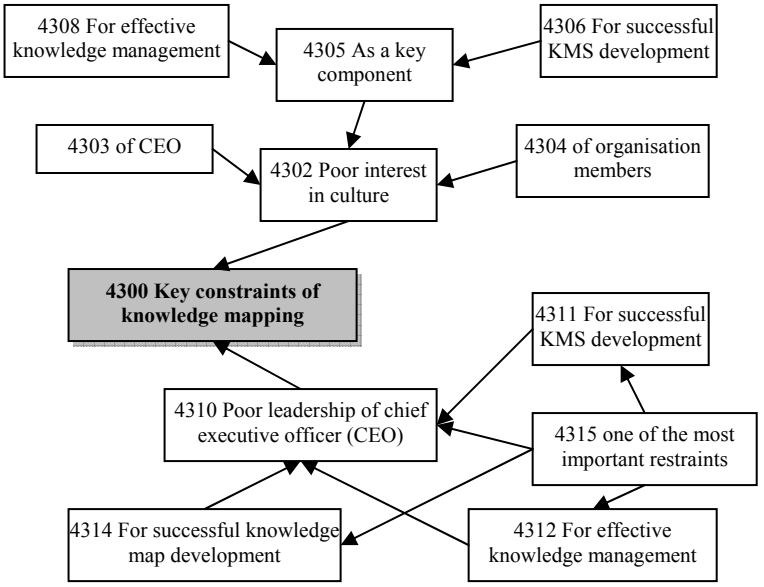


Figure 5.25 A cognitive map of the insights of the interviewee project manager OGK on the constraints of the knowledge mapping within construction project organisation

In contrast, it has been observed by knowledge manager JEP and project member JHO that shortage of communications (4401) between chief executive officers or the executives and knowledge mapping teams (4402) is a key constraint for good knowledge mapping within construction project organisation. Within this context, knowledge manager JEP (see cognitive map Figure 5.26) articulated the key constraints as follows:

"I think…and believe …poor communication and ....understanding … each other ….between chief executive officer and knowledge map

developers is a key cause of poor knowledge map creation and also, the gaps between the key stakeholders of company and knowledge mapping team members maybe…can be the causes for poor knowledge mapping. I thin so…… Furthermore, I can insist that adherence of traditional methods and rejection of organisation members for introducing new technologies…also may be key constraints ……you know…In addition, inflexibility of organisation structure and poor interest of staffs and the executives…...also…it can be key restraint of knowledge mapping. That is all…"

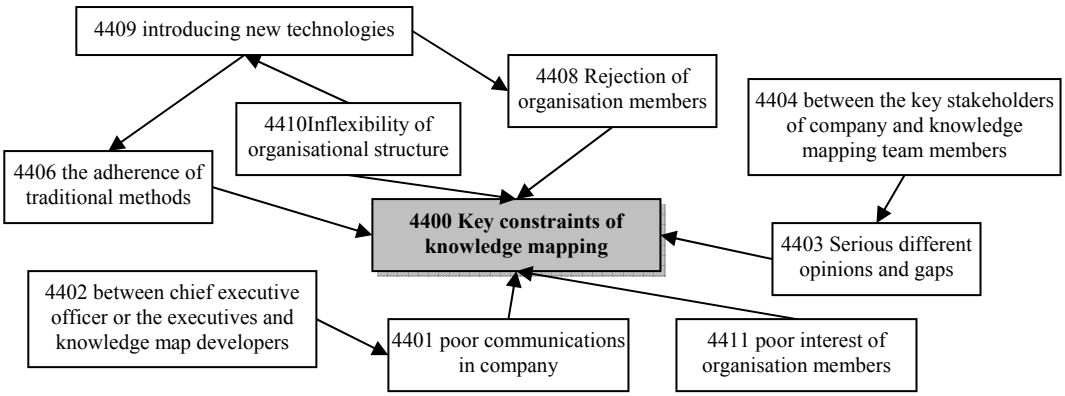


Figure 5.26 A cognitive map of the insights of the interviewee knowledge manager JEP on the constraints of knowledge mapping within construction project organisation

Furthermore, poor professional knowledge mapping training systems (4502) and knowledge mapping strategies and knowledge (4505, 4506) have been provided as critical constraints by project manager KIK, knowledge manager TWK and project members HSC and JHO. Project member HSC (see cognitive map Figure 5.27) captured this agreement as follows:

"Firstly, I think I can mention that developing of human resources for successful knowledge mapping…I mean knowledge mapping experts…is

important. This means that training systems and employment of knowledge mapping professionals who have professional ability and knowledge about construction project and knowledge mapping are necessary, but I think that ….it may be poor ..and……so weak and poor knowledge mapping professionals can develop poor or wrong knowledge maps. Therefore, I think human resource management and development (HRM and HRD) may be also a key restraint for knowledge mapping….You know what I am saying?"

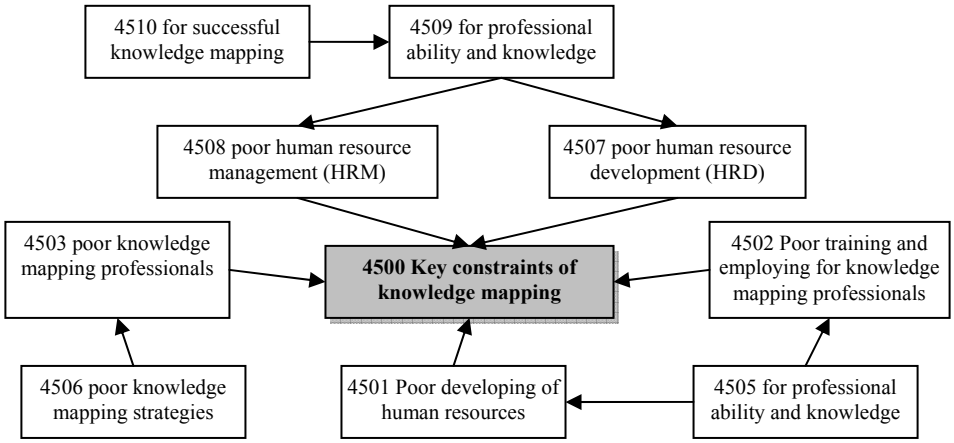


Figure 5.27 A cognitive map of the insights of the interviewee project member HSC on the constraints of the knowledge mapping within construction project organisation

In addition, a variety of constraints of knowledge mapping were identified as the knowledge mapping strategy lead (4506). Project manager OGK and knowledge manager TWK, for example, remarked that knowledge users like construction engineers and site managers must be considered as a key strategic factor for successful knowledge mapping and poor tools and systems of knowledge mapping (4505) were also suggested as key constraints within construction project organisation. Project manager SSK emphasised that if a knowledge map is developed without any appropriate strategy the knowledge map will be

inappropriate and will ultimately fail.

Synthesising the key restraints of knowledge mapping within construction project organisation

As has seen in Figures 5.25 – 5.27, there are a variety of constraints to knowledge mapping within construction project organisations. The following Table 5.11 summarises the key constraints to knowledge mapping.

Table 5.11 A synthesis of the insights of interviewees on the constraints of knowledge mapping within construction project organisations

	Area	Major constraints	
Classification	Construction project area	Poor leadership of chief executive officer (4310)	-Cost for knowledge map development -Time for knowledge map development -Shortage of professional training for knowledge mapping (4502, 4503) -Different opinions and gaps between the key stakeholders or chief executive officer and knowledge map developers (4403, 4404)
		Poor organisation culture	-Inflexibility of organisation structure (4410) -Rejection of organisation members for new technologies (4406, 4408) -Poor interest and concern of organisation members (4411) -Adherence of tradition and custom (4406)
	Knowledge management area	Poor professional knowledge mapping training (4501, 4502)	-Lack of knowledge mapping experts (4507) -Lack of Knowledge mapping training experts (4501) -Poor knowledge mapping training and system (4501, 4502, 4505)
		Poor knowledge mapping knowledge (4505. 4507, 4508)	-Poor tools, techniques and systems for effective and successful knowledge mapping: Knowledge breakdown structure; Knowledge visualisation process and system; Knowledge codification process and system; Knowledge classification process and system; knowledge transfer process and system (4505. 4507, 4508)
		Poor knowledge mapping strategy (4506)	-Strategy for effective tacit knowledge share and transfer -Strategy for effective explicit knowledge share and transfer

5.3.5 Factors about unsuccessful knowledge mapping

In order to successfully develop an appropriate knowledge map model proposed in this study, the constraints of knowledge mapping which lead to the future of knowledge mapping in past projects were identified. A variety of factors which lead to unsuccessful knowledge mapping were suggested by the interviewees. Shortage of knowledge mapping professionals (4708) and poor expert training system (4705, 4706) were emphasised and a variety of unsuccessful factors by poor leadership of the executives or chief executive officer (4703, 4704) like enough mapping project cost and time (4701, 4702) stressed by the interviewees.

Within this context, knowledge manager TWK (see cognitive map Figure 5.28) described the unsuccessful factors to knowledge mapping in company as follows:

> *"In my case, I have experienced, so, I believe .. because I am a knowledge manager…so, I can say that knowledge mapping projects can be actually cancelled or failed by insufficient cost and time decided by poor leadership of chief executive officer (CKO) or chief executive officer (CEO) and also, poor knowledge mapping professional training and education for human resource development (HRD) can be key unsuccessful factors ……"*

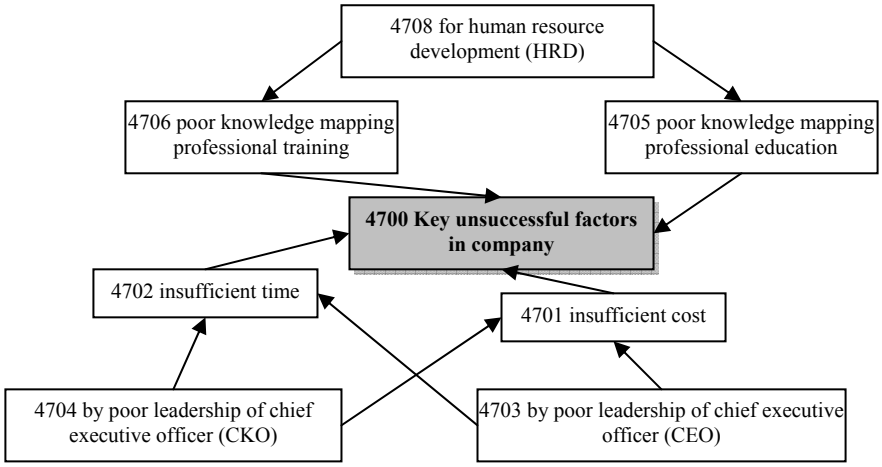


Figure 5.28 A cognitive map of the insights of knowledge manager TWK on the unsuccessful factors to knowledge mapping in company

In contrast, an appropriate organisation culture was seen as a key barrier to successful knowledge mapping. Within this context, knowledge mapping approach can be influenced by poor understanding and interest of organisational members (4801). From this perspective, project manager KIK stressed that poor support of staff (4801), such as unconcern of knowledge mapping and adherence of traditional methods and systems (4802, 4803), is an unsuccessful factor to knowledge mapping. Project manager KIK (see cognitive map Figure 5.29)

articulated the unsuccessful factors to knowledge mapping in company as follows:

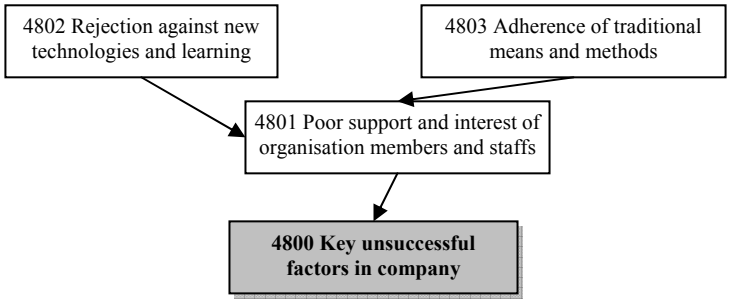


Figure 5.29 A cognitive map of the insists of project manager KIK on the unsuccessful factors to knowledge mapping in company

Furthermore, knowledge managers TWK and JEP and project manager OGK affirmed that wrong selection of knowledge map model components can derive a number of problems from knowledge management system built by poor knowledge mapping and poor compatibility with the other technologies, such as project management information systems (PMIS), expert systems and human resource management systems (HRMS), was emphasised as a vital unsuccessful factor within company.

Synthesising the insights of the interviewees on the unsuccessful factors of knowledge mapping

As shown in Figure 5.28 and Section 5.29, there are a variety of unsuccessful factors to knowledge mapping within company. Table 5.11 summarises the unsuccessful factors to knowledge mapping in company.

Table 5.12 A synthesis of the insights of the interviewees on the unsuccessful factors to knowledge mapping in company

Classification	Area	Unsuccessful factors		
	Knowledge mapping area	Poor compatibility to the other technologies and systems		-Project management information system -Human resource management system -Expert system
		Poor knowledge mapping strategy and theory		-Wrong selection of key knowledge map components -Poor knowledge classification and knowledge visualisation method -Knowledge mapping tools and techniques -User-focused strategy -Human resource-based strategy -Tacit knowledge-based strategy
	Construction project area	Individual area	Poor support and interest of members and staffs (4801)	-Adherence of traditional means and methods (4803) -Rejection against new technologies and learning (4802)
		Organisational area	Poor leadership of chief executive officer and the executives (4703, 4704)	-Poor training and education system for human resource development ((4708) -Insufficient knowledge mapping time and cost (4701, 4702)

5.4 Testing of the research hypotheses

5.4.1 Introduction

This section presents the key results of hypotheses testing. The three hypotheses (Hypoyhesis1-1, 1-2 and 1-3) based on the project-based resources are discussed and tested (Section 5.4.2). Next, the three hypotheses (Hypothesis 2-1, 2-2 and 2-3) based on the interaction between the key knowledge map model components articulated in Section 3.2 are discussed and tested (Section 5.4.3). At the end of this section, the meta-hypothesis is discussed and tested (Section 5.4.4).

5.4.2 Project-based resources

In Section 3.4, the three research hypotheses were formulated on the construction project-based resources: construction actors; knowledge transfer technologies; and construction processes. The following sub-sections discuss the three research hypotheses set out in Section 3.4.

5.4.2.1 Hypothesis 1-1: construction actors

Hypothesis 1-1: Construction actors

Knowledge mapping is more likely to be successful when construction actors who are critical and necessary to successfully perform construction projects are effectively integrated into the knowledge mapping approach.

The research findings provide general support for "*Hypothesis 1-1*". Construction actors were seen as a necessary knowledge mapping component. It was argued and recognised that all the construction actors share and transfer key project-based knowledge to the other for effective construction project performance and management within construction project organisations (Section 3.2.3 and Section 5.3.2.2.3).

From this perspective, in order to successfully complete construction projects, a variety of construction actors (such as professionals like architects, project managers, quantity surveyors, lawyers and site supervisors and construction operatives like bricklayers, plumbers and painters outsourced from sub-contractors) are employed and deployed according to their capacity and knowledge (Section 5.3.2.2.3).

Furthermore, construction actors are seen as the key project-based knowledge owners and users within construction project organisations. Construction actors have their own various and different project-based knowledge including data and information, such as explicit knowledge like regulations, procedures and manuals and guide books and tacit knowledge like experiences, techniques, know-how and insights which are used to effectively perform project performance within projects and organisations (Section 5.3.2.2.2 and Section 5.3.2.2.3).

This ultimately means that capacity and knowledge of construction actors can be improved through enhancing project-based learning of construction actors, effectively transferring project-based knowledge between construction actors within and across construction project organisations (Section 5.3.2.2.2, Section 5.3.2.2.3 and Section 5.3.2.2.5).

From this perspective, it can be said that construction actors must be considered and integrated as a critical component for successful knowledge mapping approach. Consequently, the knowledge mapping will be more effective to improve project performance and to enhance project-based learning through project-based knowledge transfer.

5.4.2.2 Hypothesis 1-2: knowledge transfer technologies

Hypothesis 1-2: Knowledge transfer technologies
Knowledge mapping is more likely to be successful when the knowledge transfer technologies integrated as a key knowledge mapping component.

In the construction industry, technologies have been recognised as key facilitators and supporting tools for effective knowledge management, particularly for knowledge transfer in construction projects and construction project organisations. knowledge transfer technologies are utilised by construction actors in order to effectively transfer their own different project-based knowledge including data and information for effective project performance improvement (such as social gathering and meeting for tacit knowledge transfer, the inter-based systems like e-mail systems and knowledge management systems and digital cameras and digital recorders for explicit knowledge transfer and telephones, mobile phones, expert systems and radios for both of tacit and explicit knowledge transfer) (Section 2.2.6, Section 5.3.2.2.5 and Section 5.2.3).

Within this perspective, it was emphasised that knowledge transfer technologies are essential for effective project performance improvement through effective construction project-based knowledge transfer between construction actors and their teams within and across construction project organisations. For example, problem-solving and decision-making capability can be effectively improved

through right project-based knowledge transferred by knowledge transfer technologies. The constructability of construction projects is ultimately improved (Section 5.3.2.2.5 and Section 5.3.3). Furthermore, the research findings confirmed that the capability and skills of project members and the competency of companies can be systematically improved and fortified through effective project-based knowledge transfer including data and information between project members and their teams within and across construction project organisations (Section 5.3.3).

This ultimately means that construction actors use a number of technologies to effectively transfer their own different project-based knowledge including data and information within and across construction project organisations. As a result, the research findings observed that project performance can be effectively improved and project-based learning is enhanced with improved capacity and skills of project members (Section 5.3.2.2.5 and Section 5.3.3).

From this perspective, it can be said that knowledge transfer technologies must be considered and integrated as a critical part for successful knowledge mapping approach. As a consequence, the knowledge mapping will be more successful for project performance improvement and project-based learning enhancement through project-based knowledge transfer.

5.4.2.3 Hypothesis 1-3: construction processes

Hypothesis 1-3: Construction processes

Knowledge mapping is more likely to be successful when construction processes are integrated into the knowledge mapping approach.

A number of specific characteristics of construction project organisations have been investigated (Section 2.2). In particular, it has been observed that there are a variety of unique characteristics of construction processes. Within this context, it has been argued that construction processes are a necessary project component for

effective project performance (Section 2.2.5).

Furthermore, the research finings identified that construction processes are key component and fundamental unit for effective construction project performance within construction projects and construction project organisations (Section 5.3.2.2.4). From this perspective, it was insisted that construction processes must be classified into construction project management system-based processes and construction work-based processes in order to successfully develop an appropriate knowledge mapping according to each project (business) type (for example high rise buildings, official buildings, commercial buildings, remodeling projects, industrial facilities, education/cultural facilities, sports facilities, medical facilities, tourist facilities, religious facilities and housings). This means that both management system-based processes and construction work-based processes consist of their own different processes and sub-processes and they are also performed by different actors which use different resources, knowledge and skills (Section 5.3.2.2.4 and Section 5.3.3). From this perspective, the research findings argued that construction process-based knowledge including data and information is a type of construction project-based knowledge which is used for effective project performance (Section 5.3.2.2.2).

This ultimately means that construction projects are accomplished through successful construction process performance by construction actors. From this perspective, it can be said that construction processes must be considered as a key knowledge mapping model component. However, construction processes must be classified into two appropriate process groups for successful knowledge mapping approach within construction project organisations: construction project management system-based processes; and, construction work-based processes (Section 5.3.2.2.4 and Section 5.3.3).

This means that both types of construction processes must be considered as a key knowledge mapping approach component (Section 5.3.2.2.4 and Section 5.3.3).

As a consequence, the knowledge mapping will be more successful for project performance improvement and project-based learning enhancement through project-based knowledge transfer

5.4.3 The interaction between the knowledge map model components

As has been argued in Section 2.2, there are a variety and number of specific characteristics of construction project organisations, such as project-based knowledge view, learning organisation-based view, construction actor-based view, construction process-based view and knowledge transfer-based view. Therefore, investigating and applying the key and various characteristics of construction project organisations may be key and essential for an appropriate knowledge mapping proposed in this study. Within this regard, this study has already adopted the key knowledge map model components in its model (Section 3.2). The next sections are to test the research hypotheses articulated on the interaction between the knowledge map concept model components.

5.4.3.1 Hypothesis 2-1: The interaction between construction actors and knowledge transfer technologies

Hypothesis 2-1: Construction actors and knowledge transfer technologies

Knowledge mapping which integrates construction actors and knowledge transfer technologies will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

The research findings identified that construction actors utilise the official and unofficial technologies (such as mobile phones, personal digital assistants (PDA), e-mail systems and knowledge management systems) in order to effectively transfer project-based-based knowledge like construction actor-based knowledge, construction process-based knowledge and construction equipment-based

knowledge between construction actors and their teams within and across construction project organisations (Section 2.2, Section 2.4 and Section 5.3.2).

Furthermore, the research findings confirmed that construction actors are key users of knowledge transfer technologies within construction projects and organisations. Furthermore, knowledge transfer technologies are utilised to effectively transfer project-based knowledge by construction actors, in which project performance is improved and capability and knowledge of project members are improved (Section 5.3.2, Section 5.3.3 and Section 5.3.4).

Within this context, it was remarked by the interviewees that some knowledge specific technologies are more useful tools to effectively transfer project-based knowledge including data and information within construction projects and organisations. Further, the research findings emphasised that more effective knowledge transfer technologies must be developed for effective project-based knowledge transfer within and across construction project organisations (Section 5.3.2.2.5 and section 5.3.5).

However, the most important point is that construction actors do not clearly know what and how the knowledge transfer technologies can be used and available. Despite of this, it was strongly emphasised that construction actors are actively utilising knowledge transfer technologies in order to effectively transfer their own different knowledge including data and information for effective project performance (Section 2.2.6, Section 2.4.1 and Section 5.3.2.2.5).

From this perspective, it can be said that knowledge transfer technologies are utilised to effectively transfer construction project-based knowledge (for example, construction actor-based knowledge and construction process-based knowledge) which are owned and used by construction actors. Therefore, an appropriate knowledge mapping which is considered and integrated the interaction between construction actors and knowledge transfer technologies is effective for project

performance improvement and project-based learning enhancement through effective project-based knowledge transfer between construction actors and their teams within construction project organisations (Section 2.2.6, Section 2.4.1, Section 5.3.2.2.2, Section 5.3.2.2.5 and Section 5.3.3).

5.4.3.2 Hypothesis 2-2: The interaction between construction actors and construction processes

Hypothesis 2-2: Construction actors and construction processes

Knowledge mapping which integrates construction processes and construction actors will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

It has been argued that construction actors and construction processes are key and necessary element in construction projects and organisations, as key knowledge owners, knowledge users and project performers and key fundamental unit for effective project performance (Section 2.2). This means that construction projects are a continuum and conglomeration of processes which are always performed by construction actors within construction project organisations.

Within this perspective, the research findings identified that construction projects are performed through construction processes by construction actors within construction project organisations (Section 5.3.2.2.3 and Section 5.3.2.2.4). Furthermore, it was emphasised that construction process-based knowledge as a key construction project-based knowledge is owned and used by construction actors (Section 5.3.2.2.2 and Section 5.3.2.2.3). From this perspective, it can be said that construction actors are necessary for effective project performance within construction project organisations.

Furthermore, construction processes are a key fundamental unit for effective

project performance within construction project organisations because construction projects are achieved with performing all construction processes by construction actors (Section 2.2 and Section 5.3.2.2.4).

Within this context, it can be insisted that construction actors and construction processes are closely related and interacted each other during project performance within construction project organisations. In particular, it was emphasised that construction actors are key construction process performers (Section 5.3.2.2.3 and Section 5.3.2.2.4). Moreover, it was noticed that construction actors are key construction process-based knowledge owners and users within construction projects and organisations (Section 2.2, Section 5.3.2.2.2, Section 5.3.2.2.3 and Section 5.3.2.2.4).

From this perspective, it can be said that the interaction between construction actors and construction processes must be considered and integrated for an appropriate knowledge mapping approach which is more effective to nurture knowledge capital for effective project performance improvement and project-based learning enhancement through project-based knowledge transfer between construction actors within and across construction project organisations (Section 2.2.6, Section 2.4.1, Section 5.3.2.2.2, Section 5.3.2.2.5 and Section 5.3.3).

5.4.3.3 Hypothesis 2-3: The interaction between knowledge transfer technologies and construction processes

Hypothesis 2-3: Knowledge transfer technologies and construction processes

Knowledge mapping which integrates knowledge transfer technologies and construction processes will improve project performance and learning within temporary construction project organisations - compared to knowledge mapping approach which does not integrate these components.

In construction projects and organisations, it has been argued that knowledge

transfer technologies are key tools for effective construction project process-based knowledge transfer between construction actors and their teams within and across construction project organisations (Section 2.2.6 and Section 2.4.1). Within this perspective, the research findings identified that construction project process-based knowledge is a type of project-based knowledge within construction project organisations (Section 5.3.2.2.2) where construction projects are accomplished through a different number of construction processes which are effectively performed through construction process-based knowledge transfer by construction actors. This means that knowledge transfer technologies are utilised to effectively perform projects within construction project organisations (Section 5.3.2.2.2, Section 5.3.2.2.4 and Section 5.3.2.2.5).

Therefore, it can be asserted that construction processes and knowledge transfer technologies must be considered as key knowledge mapping component. Furthermore, the interaction between both construction processes and knowledge transfer technologies must be considered and integrated for successful knowledge mapping within construction project organisations.

The research findings identified that there are a variety of knowledge transfer technologies within construction project organisations, such as telephones, e-mail systems, mobile phones and knowledge management systems (Section 5.3.2.2.4). Further, the research findings confirmed that the technologies are used by construction actors for effective problem-solving and decision-supporting during project process performance within construction project organisations (Section 5.3.2.2.4 and Section 5.3.3).

Therefore, it can be said that knowledge transfer technologies and construction processes must be considered as knowledge mapping component. Furthermore, the interaction between both knowledge transfer technologies and construction processes must be integrated for an appropriate knowledge mapping within construction project organisations. As a result, the knowledge map can improve

construction project performance and enhance project-based learning through effective construction process-based knowledge transfer within construction project organisations (Section 2.2, Section 5.3.2.2 and Section 5.3.3).

5.4.4 Testing of meta-hypothesis

Meta-hypothesis:

Knowledge mapping is more likely to promote effective project performance and learning within temporary construction project organisations when the construction actors, construction processes and knowledge transfer technologies are effectively integrated - compared to knowledge maps developed without the appropriate development and integration of construction actors, construction processes and knowledge transfer technologies.

In the previous sections (Section 5.3.2.1, Section 5.3.2.2, Section 5.3.3, Section 5.3.4 and Section 5.3.5), it has been confirmed that the three key construction project components proposed in this study (construction actors, construction processes and knowledge transfer technologies) are necessary for an appropriate knowledge mapping. Within this context, the research findings identified that there are a variety barriers in the integration of the three key components to the knowledge mapping.

First, construction actors have been considered as a key knowledge map component because of their role as key project performers, construction project-based knowledge owners and construction project-based knowledge users and managers within construction project organisations (Section 2.2). From this perspective, the research findings confirmed that construction actors are a necessary element of construction projects (Section 5.3.2.2.3).

However, the research findings noticed that the integration of construction actors is difficult to integrate to the knowledge mapping because there are too many construction actors in construction project organisations. Further, they have

different roles, tasks and knowledge and use different project resources to perform projects (Section 5.3.2.2.2, Section 5.3.2.2.3 and Section 5.3.2.2.4).

Within this context, the research findings stressed that construction actors must be classified into strategic construction actors and operational construction actors and integrated to the knowledge mapping for effective knowledge mapping approach (Section 5.3.2.2.3). As a consequence, although construction actors are difficult to be integrated to the knowledge mapping they must be considered as a key knowledge mapping component (Section 5.3.4 and Section 5.3.5).

The second component adopted in this study is construction processes (Section 3.2). In construction project organisations, it has been argued that construction processes are always implemented by construction actors and a key unit for effective project performance (Section 2.2). Furthermore, construction process-based knowledge which is a type of project-based knowledge is transferred through knowledge transfer technologies by construction actors within construction project organisations (Section 5.3.2.2.2).

Within this context, the research findings confirmed that construction projects are performed through different construction processes by construction actors. Furthermore, it has been observed that there are a number of different construction processes in construction projects in which different project resources and technologies are used to perform construction processes by different construction actors (Section 5.3.2.2.2, Section 5.3.2.2.3 and Section 5.3.2.2.4). Within this context, the research findings stressed that the construction processes must be classified into management system-based processes and construction work-based processes to effectively integrate to knowledge mapping (Section 5.3.2.2.4). As a result, it was confirmed that although construction processes are difficult to be considered to the knowledge mapping construction processes must be integrated for an appropriate knowledge mapping approach (Section 5.3.2.4, Section 5.3.4 and Section 5.3.5).

Final, knowledge transfer technologies have been selected as a key knowledge mapping approach component (Section 3.2). Within this regard, it has been argued that knowledge transfer technologies are useful for effective project-based knowledge transfer within construction project organisations where construction actors use knowledge transfer technologies in order to more easily and quickly access to the right knowledge and knowledge owners at the right time (Section 2.2).

From this perspective, the research findings identified that a number knowledge transfer technologies are utilised to successfully perform projects by construction actors (such as e-mail systems, digital cameras, MSN messenger systems and knowledge management systems) (Section 5.3.2.2.5).. However, it was insisted that the knowledge transfer technologies must be classified into explicit knowledge transfer-based technologies and tacit knowledge transfer-based technologies for appropriate knowledge mapping approach within construction project organisations (Section 5.3.2.2.5 and 5.3.3).

As a result, a number of knowledge transfer technologies are utilised by construction actors to effectively transfer project-based knowledge within construction project organisations (Section 2.2.5). Therefore, knowledge transfer technologies must be considered as a key knowledge mapping component to the knowledge mapping, but it is difficult to integrate the technologies (Section 5.3.2.2.5). Within this context, the research findings insisted that knowledge transfer technologies must be classified into explicit knowledge transfer-based technologies and tacit knowledge transfer-based technologies for an appropriate knowledge mapping approach (Section 5.3.2.2.5 and 5.3.3).

In brief, the selection of key project resources as the key knowledge mapping approach components is important, but difficult. From this context, it was confirmed that effective application of the adopted components is complicated

and difficult, but it must be sought to effectively integrate the components and the interactions between the components for an appropriate knowledge mapping. The research findings insisted that each of the components must be classified into different groups to successfully integrate to the knowledge mapping: into strategic construction actors and operational construction actors; into management system-based processes and construction work-based processes; and, explicit knowledge transfer-based technologies and tacit knowledge transfer-based technologies (Section 5.3.2, Section 5.3.3, Section 5.3.4 and Section 5.3.5).

5.5 Summary and link

In this chapter, the key research findings derived from the exploratory phase have been presented and the meta-hypothesis and sub-hypotheses have been discussed and tested in this chapter. In the next chapter, the key conclusion of this study will be discussed and presented.

Chapter 6 Conclusions

6.1 Introduction

This chapter summarises the key research findings and discusses the implications for theory and practice. The structure of this chapter is as follows:

(1) key results are summarised;
(2) insights on the overall research problem and research questions are presented;
(3) implications on the theory of knowledge mapping are drawn;
(5) implications on the practice of knowledge mapping are given;
(6) the limitations of this research are set out; and,
(7) future research issues are proposed.

6.2 Summary of key results

6.2.1 Definition of knowledge mapping within construction project organisations

In the literature review, knowledge mapping is broadly defined as a key cornerstone and prerequisite for successful knowledge management (Section 2.3). This study is focused on the knowledge mapping within construction project organisations (Section 2.4). The results produced the following definition (Section 5.3.2.1):

> ***"Knowledge mapping is a key element of knowledge management within construction project organisations which improves project performance and human capital through the identification and learning of bodies of relevant knowledge within a structured environment which promotes appropriate knowledge search, transfer and use"***

6.2.2 Summary of the research findings on the key knowledge map model components

Based on the unique characteristics of construction project organisation (Section

2.2), the key knowledge map concept model was a product of a relevant literature review (Section 2.2 and Section 3.2). In order to test the utility and application of the concept model, a single-holistic case study was adopted (Section 4.5 and Section 4.6). Figure 6.1 is the knowledge map concept model and Table 6.1 summarises the key results of research findings on the key knowledge concept model components.

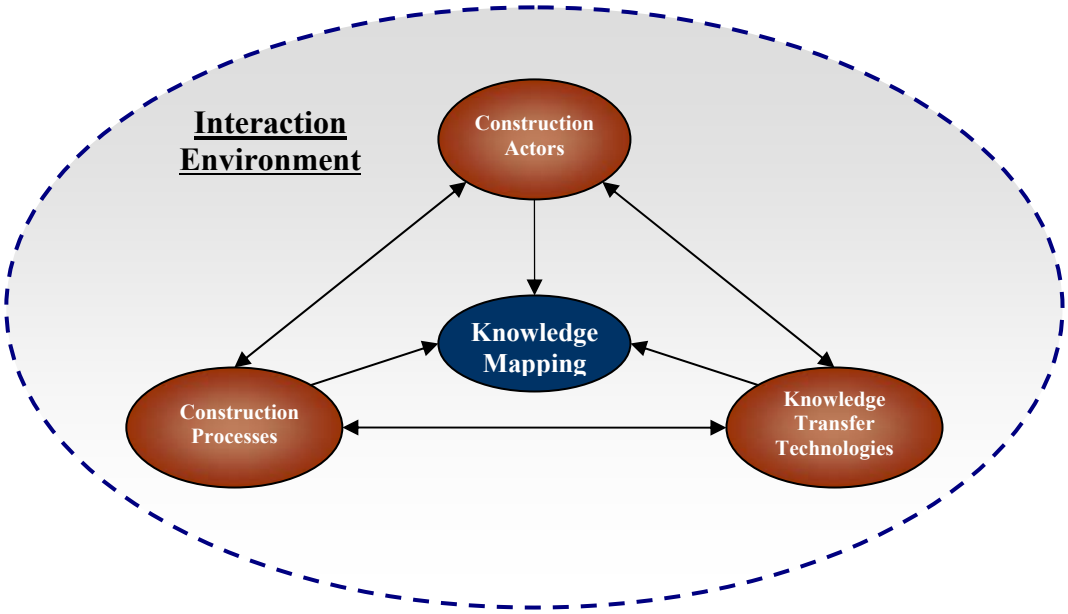


Figure 6.1 Knowledge map concept model

Table 6.1 A summary of the key variables within the knowledge map concept model

Variables	Key themes	Types	Examples of the components		Key reasons
Interaction Environment	■ One-off construction project organisation ■ Dynamic and varied project performance ■ Unknown project-based knowledge transfer activities ■ Various project resources and interactions	■ Temporary construction project organisation	■Temporary construction project organisation for successful project like commercial buildings, education facilities, sports facilities and official buildings		■ Need of effective project-based knowledge transfer for successful project performance and project-based learning
Construction Actors	■ Key project performers and managers ■ Major project-based knowledge transfer actors ■ Key project-based knowledge owners ■ Key project-based knowledge users	■ All construction actors	■ All construction actors related to project performance within construction project organisation		■ Traditional and necessary knowledge and skills owned by each construction actor ■ Traditional and necessary roles and tasks assigned to each construction actor
		■ Specific construction actors	■ Some specific construction actors: construction experts like project managers, quantity surveyors, site supervisors and architects; decision-makers like project managers, architects and clients; and, end-users of building like wives, students and patients		■ More specific knowledge and skills ■ More specific and key roles, responsibilities and authorities
Construction Processes	■ A fundamental unit for effective project performance and management ■ Key project-based knowledge management basis	■ All construction processes	■All construction processes: management system-based processes like risk management processes, time management processes and cost management processes; and construction work-based processes like piling work processes, tiling work processes and concreting work processes		■ The unique characteristic of construction project as a continuum and sequence of processes
		■ Specific construction processes	■ Some specific construction processes like design processes at the design phase		■ More possibility of cost reduction ■ More possibility of time reduction ■ More possibility of quality improvement
Knowledge Transfer Technologies	■ Knowledge transfer supporting tools for effective project performance ■ Knowledge transfer supporting tools for effective project-based learning	■ Tacit knowledge transfer technologies	ICT	Mobile phone, Telephone, PDA, Radio	■ More effective tacit knowledge transfer, having communications with knowledge owners directly
			IBT	Mobile phone, PDA, laptop	
			MBT	Mobile phone, PDA, Radio	
			SNW	Social gathering and meeting, Mentor system	
		■ Explicit knowledge transfer technologies	ICT	Mobile phone, Telephone, Homepages, Q&A system, E-mail system, KMS, MSN, PDA, Radio	■ Effective and convenient utility and access
			IBT	Mobile phone , Websites, Q&A system, E-mail system, KMS, MSN, PDA	
			MBT	Mobile phone, PDA	
			SNW	Social gathering and meeting, Mentor system	

Key: ICT: Information Communication Technologies IBT: Internet-based Technologies
MBT: Mobile-based Technologies SNW: Social Networks
PDA: Personal Digital Assistant KMS: Knowledge Management System
Q&A system: Question and Answer System

As seen in Table 6.1, project-based knowledge is owned, transferred and used to effectively perform projects and to enhance project-based learning by construction actors within temporary construction project organisation, using a variety of knowledge transfer technologies. Within this context, it can be recognised that the interaction environment has been composed of three key variables: construction actors, construction processes and knowledge transfer technologies. The key research results on the key variables of knowledge map concept model are summarised below:

■ Interaction environment

The interaction environment is taken to be synonymous with the temporary construction project organisation which is made up of different construction actors (such as architects, project managers, quantity surveyors and contractors) who have different construction project-based knowledge and often operate with different resources and techniques in order to effectively perform projects and acquire project-based knowledge (Section 2.2 and Section 3.2.1).

The research findings have confirmed that temporary construction project organisation is an interaction environment where construction actors use knowledge transfer technologies in order to effectively perform construction processes through project-based knowledge transfer mechanism (Section 5.3.2.2.1). Based on the interpretation and synthesis of the case study data, the following definition of the interaction environment was presented (Section 5.3.2.2.1):

> ***"Temporary construction project organisations require project-based knowledge to effectively perform projects where knowledge transfer***

technologies are used the project-based knowledge to effectively transfer between construction actors and their teams in order to deliver successful projects to clients."

■ Construction actors

Construction actors are a key element of construction projects and project organisations (Section 2.2.4). Different construction actors undertake specific tasks and roles, using their own unique project-based knowledge. From this perspective, it has been argued that construction actors use knowledge transfer technologies to transfer project-based knowledge; to improve their capability and skills; and, to deliver successful projects to clients (Section 2.2.2, Section 2.2.3 and Section 2.2.4).

The research findings confirmed that construction actors are a key construction project resource. Within this context, it has been stressed that construction actors must be integrated in any knowledge mapping approach (Table, 5.6, Section 5.2.2.2.2 and Section 5.3.2.2.3). The following definition of the role of construction actors within construction project organisation was produced as follows (Section 5.3.2.2.3):

"Construction actors are a key construction project component: both as key project performers and as critical project-based knowledge owners and users within construction project and construction project organisation. Therefore, construction actors must be considered as a critical part of knowledge mapping approach."

■ Construction processes

In Section 2.2.5, it has been stated that defined processes are a fundamental part of the successful delivery of construction projects. Construction processes were thus proposed as a key component of knowledge map concept model (Section 3.2).

The research findings confirmed that construction processes must be adopted and appropriately coordinated for successful knowledge mapping (Table 5.7 and

Section 5.3.2.2.4). Within this context, the case study research findings lead to the following synthesised definition of the role of construction processes for knowledge mapping:

> ***"Construction processes are a key construction project component for effective project performance and project management. Within this perspective, construction processes must be considered as a critical knowledge mapping component within construction project organisations."***

■ Knowledge transfer technologies

In the literature review, it has been argued that technologies are used to effectively transfer project-based knowledge between construction actors (Section 2.2.6). Within this context, knowledge transfer technologies have been selected as a component of the knowledge map concept model (Section 3.2.3).

The results confirmed that knowledge transfer technologies must be adopted as an integral component of any knowledge mapping approach (Section 5.3.2.2.5). The following synthesised definition of the role of knowledge transfer technologies in knowledge mapping was produced (Section 5.3.2.2.5).

> ***"Knowledge transfer technologies are used to effectively transfer project-based knowledge between construction actors and their teams within construction projects and construction project organisations. Appropriate knowledge transfer technologies must be considered as a key component for an appropriate knowledge mapping."***

6.2.3 Implications between the key knowledge map model components within the knowledge map model

In Table 3.1, the gap analysis questions were proposed to investigate the interactions between the knowledge map model components and, in so doing; test the research hypotheses (Section 3.3). Figure 6.2 presents the gap analysis framework and Table 6.2 summaries the interactions between the knowledge map concept model components.

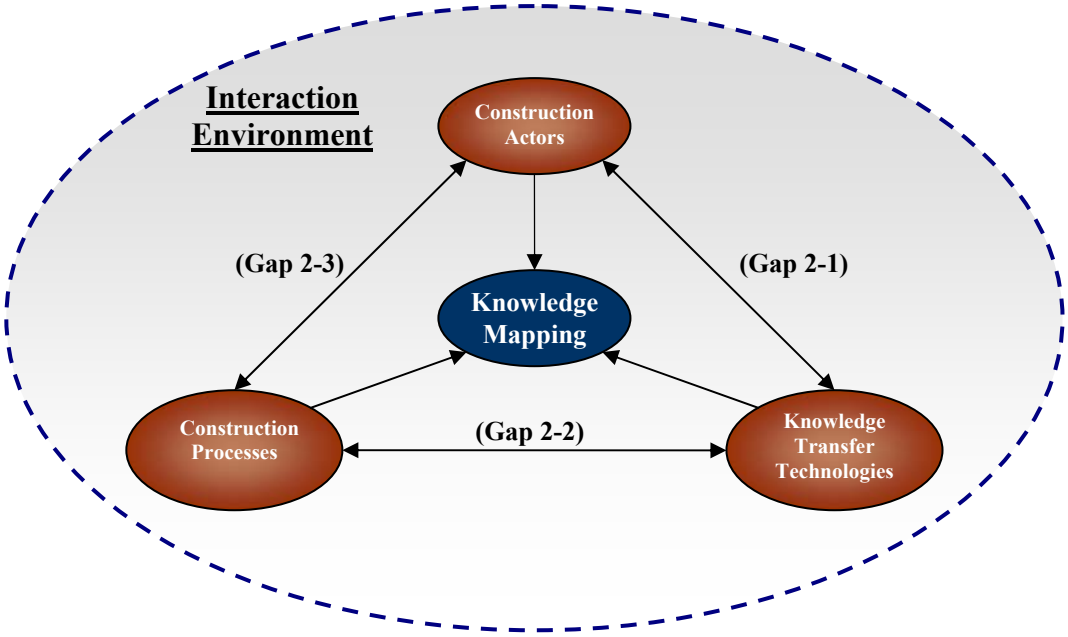


Figure 6.2 Gap analysis framework of knowledge map concept model

Table 6.2 Testing of the indicated gap analysis questions between the knowledge map model components

	Variables	Gap analysis questions	Key results
Gap 2-1	■ Construction actors and Knowledge transfer technologies	■ How can the knowledge transfer technologies be used by the construction actors to effectively transfer project-based knowledge within temporary construction project organisations?	► Tacit knowledge can be transferred by the construction actors, using and utilising some specific knowledge transfer technologies, such as social gathering and meeting, telephone, PDA and mobile phone, having good communications with the others directly. ►Shortage of concern and skill of construction actors for knowledge transfer technologies. ►Need of effective and systematical knowledge transfer technology and system development including both tacit and explicit knowledge transfer technologies. ►Need of organisational training for effective knowledge transfer technology use.
Gap 2-2	■ Knowledge transfer technologies and Construction processes	■ How can the construction processes be effectively performed and improved, using knowledge transfer technologies within temporary construction project organisations?	►Construction processes can be more effectively performed and improved by the construction actors, but the knowledge transfer technologies must be used and utilised for effective project-based knowledge transfer between construction actors within construction project organisations. ►Shortage of both knowledge transfer technologies and systems for effective construction process-based knowledge transfer, in particular tacit knowledge transfer technologies. ►Poor generation and creation of construction process-based knowledge

			►Need of organisational training for effective knowledge creation and technology use.
Gap 2-3	■ Construction processes and Construction actors	■ How can the construction actors effectively perform and improve the construction processes within temporary construction project organisations?	►Construction actors are the key construction process performers and managers. ►Construction processes can not be performed without construction actors. ►Construction actors are the key construction process-based knowledge owners and users, but the knowledge is not managed. ►Construction processes and construction actors are key elements of construction projects, but they have not been considered as management components.

Gap 2-1: Construction actors and knowledge transfer technologies

"***Gap 2-1***" is the interactions between construction actors and knowledge transfer technologies. In Section 3.2, it has been argued that construction actors use technologies to transfer project-based knowledge within and across temporary construction project organisations. Within this context, it has been confirmed by the interviewees that knowledge transfer technologies are used (Section 5.3.2.2.3 and Section 5.3.2.2.5). Further, it has been revealed that construction project performance is improved and project-based learning is enhanced through improving the capability and knowledge of construction actors (Section 5.3.3)

In addition, it has been discerned that having good communications between construction actors and their teams is a critical catalyst for effective project-based knowledge transfer within construction project organisation. From this perspective, the case study findings identified strong consensus that some specific knowledge transfer technologies, such as mobile phones and personal digital assistants, are more effective for tacit knowledge transfer (Section 5.3.2.2.3 and Section 5.3.2.2.5).

On the other hand, it was stressed that all knowledge transfer technologies, such as explicit knowledge transfer technologies and tacit knowledge transfer technologies, must be considered for effective project-based knowledge transfer within construction project organisations. However, it has been confirmed that construction actors prefer having direct communications with the other

construction actors as it enables "deep" project-based knowledge to be gained, using mobile phone, telephone, radio and personal digital assistant (Section 5.3.2.2.5 and Section 5.3.3).

Gap 2-2: Knowledge transfer technologies and construction processes

"***Gap 2-2***" is the interactions between knowledge transfer technologies and construction processes. In Section 2.2 and section 3.2, it has been argued that knowledge transfer technologies are used to effectively perform construction processes through effective project-based knowledge transfer within and across construction project organisations. Within this context, the case study research findings confirmed that knowledge transfer technologies are used by construction actors for effective construction process performance through project-based knowledge transfer within construction projects and project organisations (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.2.2.5).

Within this context, the case study research findings confirmed that some specific knowledge transfer technologies can be used to effectively transfer process-based knowledge between the construction actors and their teams within and across construction project organisations (Section 5.3.2.2.3 and Section 5.3.2.2.5).

In the interviews, two types of knowledge transfer technologies were identified. First, some knowledge transfer technologies (such as homepages, knowledge management systems, e-mail systems, mobile phones, telephones and question and answer systems (Q&A systems)) are used for only explicit knowledge transfer. On the other hand, it was stressed that tacit knowledge is more difficult to classify and be modified than explicit knowledge and tacit knowledge was focused to be more effectively shared and transfer by specific knowledge transfer technologies, having direct communications with the others, such as telephones, mobile phones, personal digital assistants (PDA), expert systems, radios; and, social networks like mentor system, social gathering and meeting (Section 5.3.2.2.5).

From this perspective, it has been highlighted that some specific technologies based on the mobile technology environment, such as mobile phones and personal digital assistants, are more effective and will be used by construction actors within construction project organisations, installing wireless broadband internet (Wibro), knowledge management system, digital camera and radio frequency identification (RFID) which can support to effectively access to right construction process-based knowledge. This means that construction actors can gain the right project-based knowledge at the right time on the construction sites (Section 5.3.2.2.5 and Section 5.3.3).

Gap 2-3: Construction processes and construction actors

From the research findings, construction processes have been confirmed key unit for effective project performance (Section 2.2.5). Construction actors have been also emphasised as key project performers, project-based knowledge users and project-based knowledge owners (Section 5.3.2.2.3).

Construction processes are performed by a variety of construction actors who have different construction project-based knowledge and often operate different project resources with different knowledge and techniques to successfully deliver projects to clients (Section 5.3.2.2.4). For example, construction actors have often faced some specific problems related to construction processes in projects where the construction actors share and transfer the project-based knowledge including data and information to effectively solve the specific problems with the other construction actors within construction project organisations (Section 2.2.6 and Section 5.3.2.2.3).

6.3 Insights on the overall research problem and research questions

The main aim of this study is to confirm or contest the utility and application of knowledge mapping in a large construction company in the South Korea. In doing

so, the validity of the knowledge map concept model articulated in this study was confirmed.

Q1. Is knowledge management an appropriate aspiration for effective project performance and project-based learning in projects and organisations?

In Section 1.2 and Section 1.3, it has been argued that there are a number of key barriers preventing the potential value of knowledge management to be realised, in particular on the integration of key project components and knowledge transfer technologies within projects and organisations. From the case study research findings, it has been confirmed that projects can be enhanced if knowledge is effectively shared and transferred between construction actors (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.3). However, it has been argued that there are a variety of problems for integrating and combining the key project resources and technologies in the knowledge management area. From this perspective, it has been argued that knowledge mapping can be effectively used as a key solution for effectively integrating and combining the key project components and technologies in the knowledge management area (Section 1.3).

> *Q11. Is knowledge mapping an appropriate tool to improve performance and enhance learning within and across construction project organisations?*

The case study research findings strongly indicated that knowledge mapping is a key component for effective knowledge management (Section 5.3.2.1 and Section 5.3.2.2). Within this context, it was confirmed that knowledge maps can effectively improve capability and knowledge of organisations members. As a result, project performance can be enhanced through project-based knowledge transfer within and across construction project organisations (Section 5.3.2.2.2 and Section 5.3.3). However, the key barriers to the successful application and utility of knowledge mapping were confirmed (Section 5.3.4 and Section 5.3.5).

From this perspective, the following research questions were embodied in order to more investigate knowledge mapping (Section 2.6).

Q2. In construction project organisations, how can an appropriate knowledge map be developed for effective project performance and learning?

Q21. What types of construction project components and knowledge transfer technologies should be part of an effective knowledge mapping approach?

The knowledge map concept model (Section 3.2) is made up of three key components: construction actors, construction processes and knowledge transfer technologies. The case study research findings identified that the three key components are appropriate as the key components of knowledge mapping within construction project organisation (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.2.2.5). Further, the case study findings confirmed that appropriate knowledge capital can be effectively generated and utilised when the three project components are considered and integrated as the key knowledge map model components (Section 5.3.2 and Section 5.3.3). In addition, it was emphasised that the three key components should be appropriately classified into different types depending on the circumstance and effectively integrated into knowledge mapping in order to transfer and share project-based knowledge within construction project organisation: strategic construction actors and operational construction actors; general management system-based processes and construction work-based processes; and, tacit knowledge transfer technologies and explicit knowledge transfer technologies (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.2.2.5).

In order to successfully develop appropriate knowledge map model (Section 3.2), integration of the three key components has been stressed as the key knowledge mapping process (Section 1.3, Section 2.5, Section 5.3.2.1 and Section 5.3.3).

Based on this context, the following research question was articulated in order to effectively integrate the three key components into the knowledge mapping (Section 2.6).

Q22. How should the knowledge map components be integrated?

From the case study findings, it was identified that the three key project resources (Section 3.2) must be considered as the knowledge map concept model components for appropriate knowledge mapping (Section 5.3.2, Section 5.3.3, Section 5.3.4 and Section 5.3.5). From this perspective, it was emphasised that each of the components was defined as the key knowledge map component (Section 5.3.2). Furthermore, it was confirmed that the three key components must be classified into appropriate types in accordance with project and business needs, objectives or strategies in the circumstance (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.2.2.5). In the knowledge mapping process, each component's types can be appropriately and selectively considered as the knowledge map model components by need, objective and strategy of knowledge mapping. Within this context, type of knowledge mapping is decided (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.2.2.5).

6.4 Implications for knowledge mapping theory

The case study findings have produced a synthesised definition of knowledge mapping (Section 6.2.1); the utility and validity of the knowledge map model was substantially justified (Section 6.2.2); and, the key interactions between the knowledge map model components were detailed (Section 6.2.2.2). The implications for knowledge mapping theory provided from these results are grouped as focus: differentiated knowledge mapping approaches; and, the improved knowledge map approaches embodied within construction project organisations.

6.4.1 Differentiated knowledge mapping approaches

As has been mentioned previous sections, knowledge mapping can vary according to the its needs, objectives and strategies of particular projects and companies. Within this context, it was confirmed from the research findings that the three key knowledge map model components (construction actors, construction processes and knowledge transfer technologies) must be appropriately classified into (Section 5.3.2.2). After that, each of the components must be adopted and integrated for successful knowledge mapping approach. Figure 6.3 is the original knowledge map concept model articulated in this study (Section 3.2).

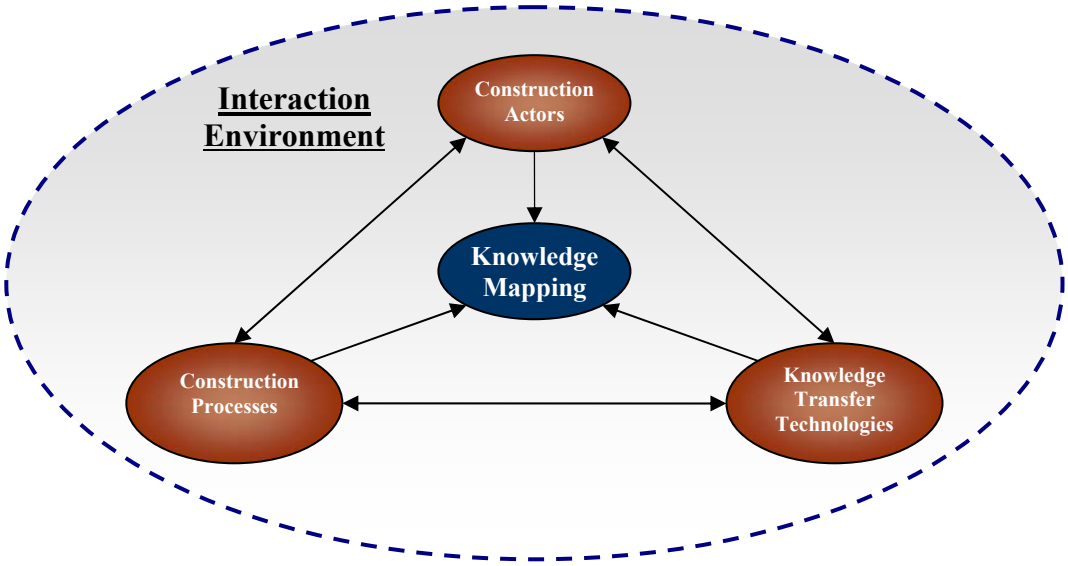


Figure 6.3 The original knowledge map concept model for this study

The case study results confirmed that the key three knowledge map model components must be classified into different types depending on the circumstance in which knowledge map model types are formed for effective corporate and project performance improvement within construction project organisations, transferring project-based knowledge: specific construction actors and all construction actors; generic management-based processes and specific construction work-based processes; and, tacit knowledge transfer technologies

and explicit knowledge transfer technologies. These arguments are presented below.

Types of construction actors

Construction actors which have their own different the bodies of knowledge related to construction projects have their own essential roles and tasks in projects and organisations in which they perform construction projects, using their own different project resources and project-based knowledge (Section 2.2.4). From this perspective, it has been confirmed that construction actors are a core knowledge mapping component, as the key construction project performers, project-based knowledge owners and project-based knowledge users within construction project organisations (Section 5.3.2.2.2 and Section 5.3.2.2.3).

Nevertheless, a key insight concerning effective utility and application of construction actors in the knowledge mapping was provided from the research findings (Section 5.3.2.2.3, Section 5.3.4 and section 5.3.5). That is, in order to successfully develop an appropriate knowledge map within construction project organisation, construction actors must be classified into two groups: a generous group including all construction actors; and specific construction actors' group (Section 5.3.2.2.3 and Section 5.3.3).

The former consists of all construction actors (such as clients, designers, managers, engineers, craftsmen and sub-contractors) which must be considered and integrated as a vital knowledge map model component. Each construction actor has their own specific bodies of knowledge and skill which are used with different project resources and technologies in order to effectively perform and successfully complete projects within construction project organisations.

On the other hand, it has been confirmed that some specific construction actors (such as project managers, architects, clients, inspectors, quantity surveyors) must be optionally considered as the key knowledge mapping approach component.

The rational for this is that the specific construction actors are more important and valuable role, task, knowledge and skill for successful projects within construction project organisations, as a core project performer, project-based knowledge owner and project-based knowledge user.

Consequently, two types of knowledge maps can be distinguished on the classified construction actors within construction project organisations. Table 6.3 summarises the types of knowledge maps.

Table 6.3 Types of construction actors in the knowledge mapping

	Strategic knowledge maps "*Tactics*"	**Operational knowledge maps "*Does*"**
Key aim	■ Sharing of more important knowledge and skills owned and used by the construction actors. ■ Effective performance of more important tasks and roles ■ Effective performance of key responsibilities and authorities ■ Effective decision-making ■ Effective policy-making	■ Sharing of all the knowledge and skills owned and used by all construction actors ■ Effective performance of all the tasks and roles assigned to all the construction actors ■ Effective performance of responsibilities and authorities assigned to all the construction actors
Indicated actors	**"Specific construction actors"** ■ Decision makers, policy makers, stakeholders, auditors and planners like quantity surveyors, project managers, inspectors, architects, lawyers, end-users, site supervisors and clients	**"All construction actors"** ■ All construction actors including generic and typical construction actors like construction engineers and site managers; decision makers, policy makers, stakeholders, auditors and planners like architects, project managers; and, sub-contractors like plumbers, electricians and carpenters

Types of construction processes

As a key construction project component, construction processes are a fundamental and key unit for effective project performance within construction project organisations (Section 2.2.5). From this perspective, it has been identified that construction processes can be used as a critical knowledge mapping approach component (Section 3.2).

The case study findings confirmed that construction processes must be considered as a vital component in the knowledge mapping process. Furthermore, it was emphasised that there are two different types of construction processes which need to be integrated in the knowledge mapping process: generic management

system-based processes (for example, quality management processes, time management processes, risk management processes and cost management processes); and, specific construction work-based processes (for example, digging work processes, tiling work processes, piling work processes and concreting work processes) (Section 5.3.2.2.4). Within this regard, it was confirmed that effective knowledge mapping provides their distinctive process groups. Figure 6.4 summarises the two types of construction processes.

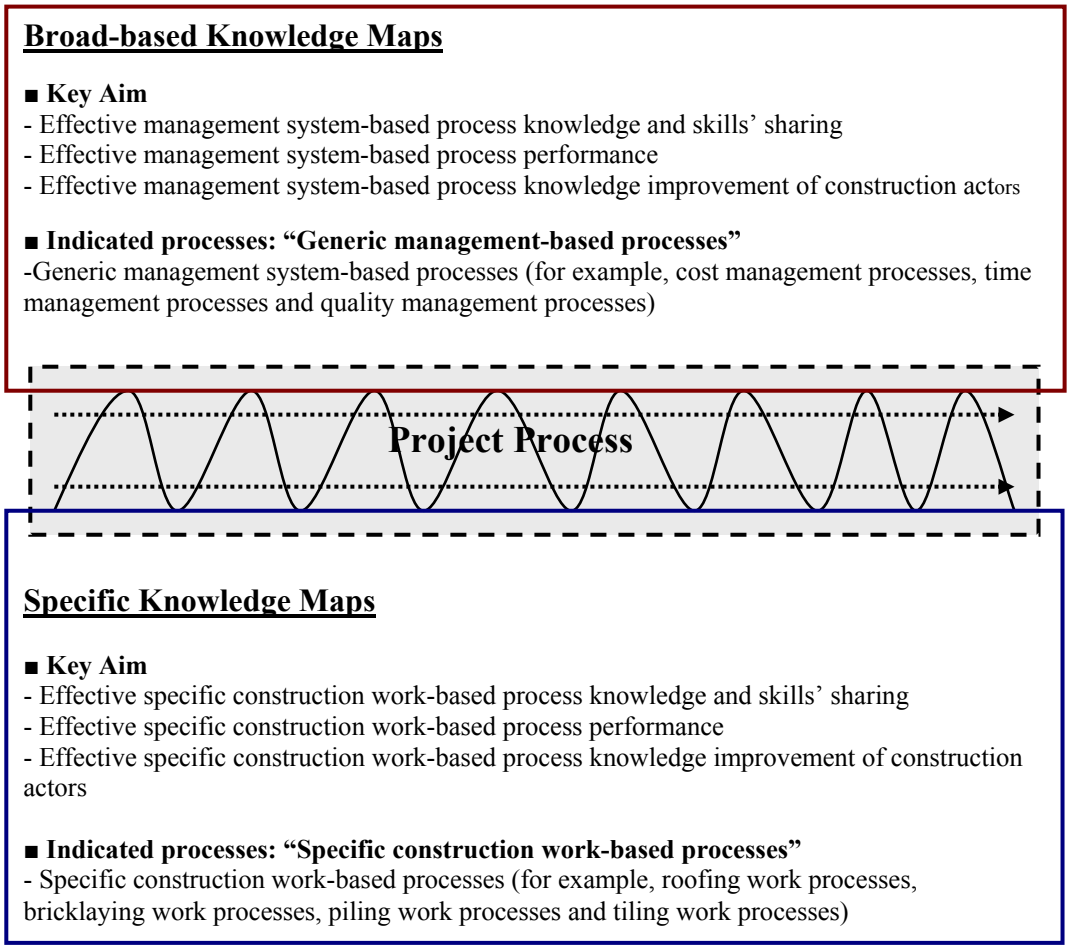


Figure 6.4 Types of construction processes in the knowledge mapping

Types of knowledge transfer technologies

Knowledge transfer technologies have been defined as key tools and means for

effective project-based knowledge transfer within construction project organisations (Section 2.2.6) and identified as a key component in the knowledge mapping concept model (Section 3.2).

The case study results recognised that some technologies can be very effective and useful tools and systems for effectively transferring and sharing project-based knowledge between construction actors and their teams within construction project organisations (Section 5.3.2.2.5). Figure 6.5 describes the types of knowledge transfer technologies.

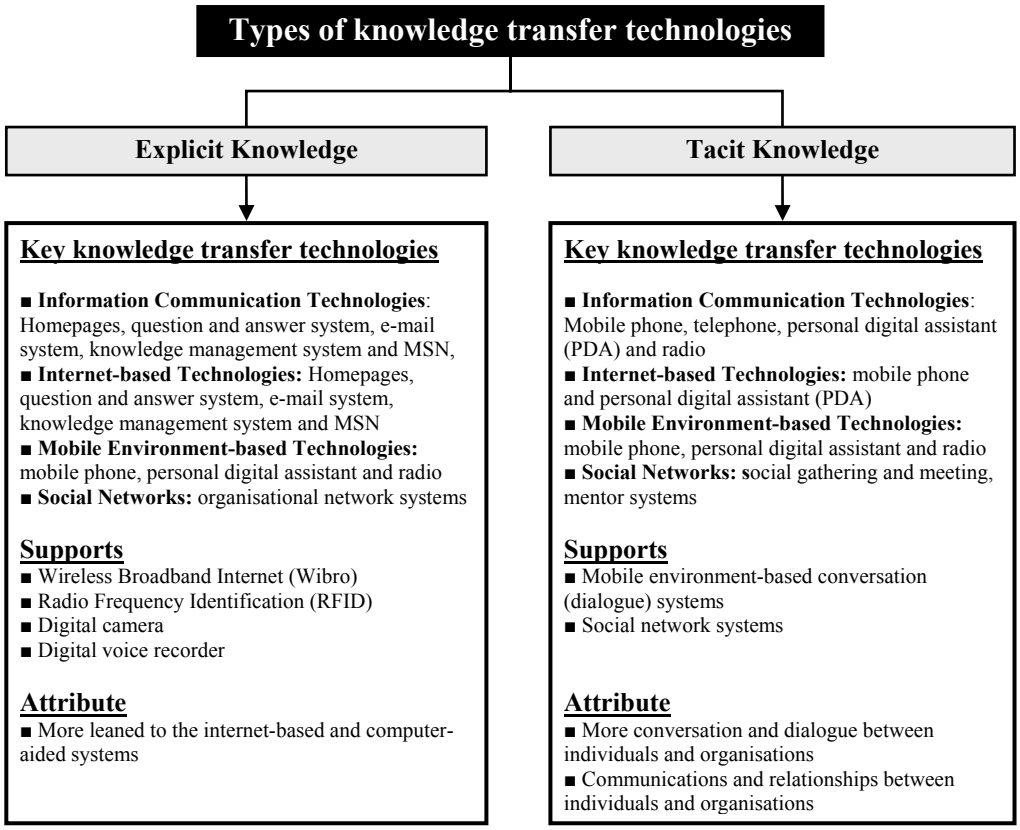


Figure 6.5 Types of knowledge transfer technologies in knowledge mapping

6.4.2 Contingency approach to knowledge map types

The results of the research findings have identified different loci for each of the knowledge mapping components identified in the concept model: strategic construction actors and operational construction actors; generic management system-based processes and specific construction work-based processes; and, tacit knowledge transfer technologies and explicit knowledge transfer technologies (Section 5.3.2.2.3, Section 5.3.2.2.4 and Section 5.3.2.2.5).

Based on the different loci, four types of knowledge maps have been created from the results of the research findings. These varying inputs are shown in Figure 6.6.

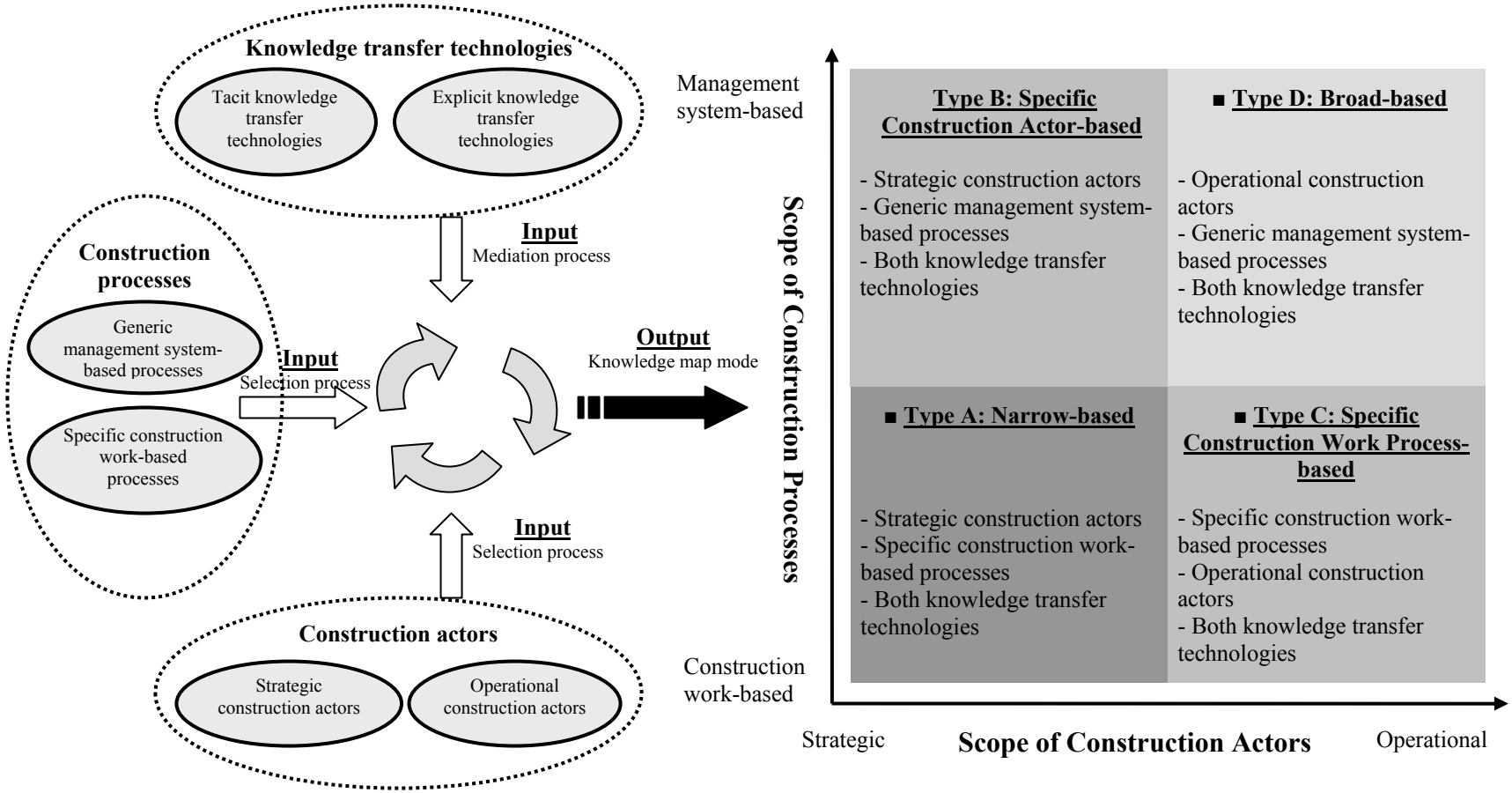


Figure 6.6 Fundamental principle of knowledge mapping

As shown in Figure 6.6, each of the knowledge mapping approach components is used as a key input and a critical determinant to create an appropriate knowledge map. Within this context, in the knowledge mapping process, as varying inputs, the different types of inputs will create correspondent different types of knowledge maps, depending on the knowledge mapping requirements.

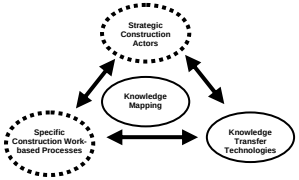
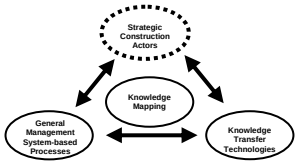
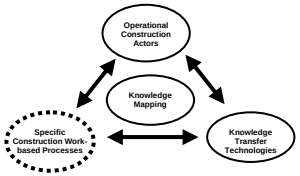
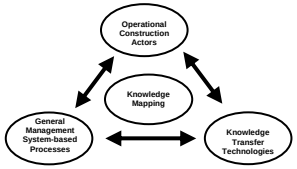
No one knowledge map model type will be appropriate for all construction project organisations, and each type has its unique context, components, potential benefits and key constraints. This means that knowledge map types can be flexibly created by the knowledge mapping components determined according to the business and project needs (Figure 6.6). In the knowledge mapping process, construction actors and construction processes are used as more important determinative factors. It is recognised that types of knowledge mapping are limited by pre-determined size and scope of both construction actors and construction processes.

However, knowledge transfer technologies have different characteristics as a key input in the mediation process. In all types of knowledge mapping, knowledge mapping should not attempt to equally use and integrate both tacit knowledge transfer technologies and explicit knowledge transfer technologies. Rather, one type of knowledge transfer technologies must be primarily adopted and used the second to support the first for successful knowledge mapping. This means that the types of knowledge transfer technologies must be considered on the knowledge management strategies: personalization approach strategy and codification approach strategy (Hansen *et al.*, 1999, Smith, 2004). Within this regard, Choi and Lee (2003) conclude in a distinction between a system-oriented and a human-oriented approach strategy. System-based strategy is more geared towards codification approach strategy. On the contrary, human-based strategy is more leaned and geared towards personalization approach strategy. Therefore, it can be said that both tacit knowledge transfer technologies and explicit knowledge transfer technologies must be considered in all types, but the balance and priority

between both knowledge transfer technologies can be adjusted on the knowledge management strategies.

The four types of knowledge mapping approaches are distinguished: narrow-based knowledge map; strategic construction actor-based knowledge map; specific construction work process-based knowledge map; and, broad-based knowledge map. Table 6.4 summarises the four types of knowledge maps: context; components; and, example of each component.

Table 6.4 Attributes, context, components and examples of each component for four types of knowledge map model within construction project organisation

Mode	Attributes	Context	Components	Example of each component
Type A (Narrow-based)		► Transfer of project-based knowledge owned and used by strategic construction actors through knowledge transfer technologies for effective specific construction work-based process performance and project-based learning	■ Strategic construction actors ■ Specific construction work-based processes ■ Both tacit knowledge transfer technologies and explicit knowledge transfer technologies	► Architects as the strategic construction actors; design process as the specific construction work-based process; and, social gathering and meeting, mobile phones and personal digital assistants (PDA) as the both tacit and explicit knowledge transfer technologies
Type B (Construction Actor-based)		►Transfer of project-based knowledge owned and used by strategic construction actors through knowledge transfer technologies for effective generic management system-based process performance and project-based learning	■ Strategic construction actors ■ Generic management system-based processes ■ Both tacit knowledge transfer technologies and explicit knowledge transfer technologies	►Quantity surveyors and project managers as the strategic construction actors; cost management processes as the generic management system-based processes; and, telephones, e-mail system and knowledge management system as the both tacit and explicit knowledge transfer technologies
Type C (Construction Process-based)		► Transfer of project-based knowledge owned and used by operational construction actors through knowledge transfer technologies for effective specific construction work-based process performance and project-based learning	■ Operational construction actors ■ Specific construction work-based processes ■ Both tacit knowledge transfer technologies and explicit knowledge transfer technologies	►All construction actors as the operational construction actors; concreting work-based processes as the specific construction work-based processes; and, telephones, e-mail systems, mentor system and radio as the both tacit and explicit knowledge transfer technologies
Type D (Broad-based)		► Transfer of project-based knowledge owned an used by operational construction actors through knowledge transfer technologies for effective generic management system-based process performance and project-based learning	■ Operational construction actors ■ Generic management system-based processes ■ Both tacit knowledge transfer technologies and explicit knowledge transfer technologies	►All construction actors as the operational construction actors; quality management processes as the generic management system-based processes; and, telephones, e-mail systems, mobile phones, personal digital assistants (PDA), social gathering and meetings, mentor system and radio, knowledge management system and project management information system as the both tacit and explicit knowledge transfer technologies

"***Type A***" represents a situation in which strategic construction actor-based and specific construction work process-based knowledge transfer motivation is high. Furthermore, the construction processes and construction actors as key knowledge map type determinants are used to create an appropriate knowledge mapping type through organic selection process. This type is appropriate for narrow-based knowledge mapping approach in which specific project-based knowledge (such as insights, experiences, intuitions and know-how) owned and used by strategic construction actors is more sought to be mapped.

This type of knowledge map consists of strategic construction actors (for example, architects), specific construction work-based processes (for example, design processes) and both tacit knowledge transfer technologies and explicit knowledge transfer technologies (for example, social gathering and meeting and mobile phones). However, as has been stressed above, both types of knowledge transfer technologies must be balanced as a key knowledge mapping approach component by pre-adopted knowledge management strategy.

Within this context, specific construction work process-based knowledge owned and used by strategic construction actors is dynamically transferred between construction actors and their teams, utilising both tacit knowledge transfer technologies and explicit knowledge transfer technologies for effective project performance and project-based learning.

In this type, architects, scheme design processes and both tacit knowledge transfer technologies and explicit knowledge transfer technologies are, for example, considered as the key components for successful scheme design production through effective design-based knowledge transfer including data and information between architectural design actors within and across construction project organisations.

"***Type B***" represents a situation in which strategic construction actor-based

knowledge transfer motivation is high and construction actors are used as the key knowledge map type determinant through organic selection process. This type is appropriate for strategic construction actor-based knowledge mapping approach in which project-based knowledge owned and used by strategic construction actors is mapped in the general management system-based processes.

In this type, strategic construction actors (for example, quantity surveyors), generic management system-based processes (for example, cost management processes) and both tacit and explicit knowledge transfer technologies (for example, telephones, e-mail systems and personal digital assistants) are considered as three key knowledge mapping components, in particular with knowledge transfer technologies balanced by knowledge management strategy.

This type is appropriate in a context in which project-based knowledge including data and information owned and used by strategic construction actors is dynamically transferred to successfully perform general management system-based processes and enhance project-based learning within and across construction project organisations, utilising all knowledge transfer technologies.

"***Type C***" represents a situation in which specific construction work process-based knowledge transfer motivation and its relevance is high. With this context, it has been shown that the construction processes are used as the critical knowledge map type determinant through organic selection process. This type is appropriate for specific construction process-based knowledge mapping in which specific construction work process-based knowledge owned and used by operational construction actors is more sought to be mapped.

In this type, operational construction actors (for example, all construction actors); specific construction work-based processes (for example, concreting work-based processes); and, both tacit and explicit knowledge transfer technologies (for example, mentor systems, radios and telephones) are considered as the three key

knowledge mapping components to develop an appropriate specific construction process-based knowledge map.

This type represents a situation in which specific construction work process-based knowledge owned and used by operational construction actors is transferred by both tacit knowledge transfer technologies and explicit knowledge transfer technologies balanced by knowledge management strategy. As a result, specific construction work-based processes can be effectively performed and project-based learning can be enhanced through project-based knowledge transfer between construction actors within and across construction project organisations.

"***Type D***" represents a situation in which all types of construction project-based knowledge, including data and information, are mapped. This type is appropriate for a broad-based knowledge mapping approach in which operational construction actors, general management system-based processes (for example, quality management processes) and both tacit and explicit knowledge transfer technologies (mobile phones, social gathering and meeting, knowledge management systems and project management information systems) are used as the three key knowledge mapping components.

This type represents a context in which general management system-based knowledge owned and used by operational construction actors are transferred for effective project performance and project-based learning within and across construction project organisations. It can be said that in this type, all construction actors and construction processes are sought to be mapped in a knowledge map.

■ Key benefits of knowledge mapping

With the knowledge mapping, a variety of benefits have been identified by the interviewees (Section 5.3.2, Section 5.3.3 and Section 5.3.5). These benefits are grouped with three areas. Table 6.5 summarises the key benefits of knowledge mapping within construction project organisations.

Table 6.5 A summary of the key benefits of knowledge mapping within construction project organisations

	Area		Key benefits
Classification	■ Construction project	► Individual area	►Effective self-evaluation ►Easier access to knowledge and knowledge owners ►Improvement of staffs' capability and knowledge ►Effective training for newcomers and new workers ►Effective project performance
		► Organisational area	►Effective self-evaluation ►Confidence and competitiveness improvement ►Organisational human resource management ►Organisational human resource development ►Improvement of customer service and satisfaction ►Improvement of construction project buildability ►Time and cost reduction/quality improvement
	■ Knowledge management	► Knowledge management area	►Knowledge generation, knowledge share, knowledge store, knowledge use, knowledge transfer and knowledge classification
			►Expert/knowledge owner-based search system development ►Knowledge-based search system development

■ Key constraints on knowledge mapping

With the knowledge mapping, a variety of constraints have been identified by the interviewees (Section 5.3.2, Section 5.3.4 and Section 5.3.5). These constraints are grouped with five areas. Table 6.6 is a summary of the key constraints on the knowledge mapping within construction project organisations.

Table 6.6 A summary of the constraints of knowledge mapping within construction project organisations

	Area		Major constraints
Classification	■ Construction project	► Poor leadership of chief executive officer	►Lack of cost for knowledge map development ►Lack of time for knowledge map development ►Shortage of professional training for knowledge mapping ►Different opinions and gaps between the key stakeholders or chief executive officer and knowledge map developers
		► Poor organisation culture	►Inflexibility of organisation structure ►Rejection of organisation members for new technologies ►Poor interest and concern of organisation members ►Adherence of tradition and custom
	■ Knowledge management	► Poor professional knowledge mapping training	►Lack of knowledge mapping experts ►Lack of Knowledge mapping training experts ►Poor knowledge mapping training and systems
		► Poor knowledge mapping knowledge	►Poor tools, techniques and systems for effective and successful knowledge mapping: Knowledge breakdown structure; Knowledge visualisation process and system; Knowledge codification process and system; Knowledge classification process and system; knowledge transfer process and system

		► Poor knowledge mapping strategy	►Strategy for effective tacit knowledge share and transfer ►Strategy for effective explicit knowledge share and transfer

6.5 Implications for practice

From the perspective of construction project organisations, the main objective is how an appropriate knowledge map can be developed for corporate and project performance improvement (Section 1.4). This means that construction project organisations need to appreciate the implications of knowledge mapping to effectively identify and integrate the project resources and technologies, and dynamic capabilities for successful knowledge mapping. The case study results, for example, are being used by HanmiParsons to progress its knowledge mapping capacities. The generic implications of knowledge mapping are described below.

■ Knowledge and knowledge management strategy-nested

Successful knowledge management requires appropriate knowledge mapping. This means that knowledge mapping must be based on knowledge and knowledge management strategy. The knowledge mapping can be a powerful tool for improving corporate and project performance, but must be driven by an appropriate knowledge management strategy, which considers the different loci of construction project resources and technologies. No one knowledge map type will be appropriate for all construction project organisations. This means that all the knowledge maps must be strategically developed, considering the knowledge mapping components determined according to the construction project organisation needs (Section 6.4). Further, it has been argued that knowledge mapping can be approached by knowledge management strategies which have been more recognised as a previous and prior process and question than knowledge mapping (Grey, 1999, Hansen *et al.*, 1999, White, 2002, Smith, 2004). Therefore, the knowledge mapping in this study should be aligned to, and effectively based on strategies formulated within construction project organisations.

■ Construction actor-based

In order to successfully produce an appropriate product, importance of human resource (such as managers, engineers, contractors, clients and end-users) has been stressed in the industries. In this regard, it has been, for example, argued that human resource-focused views must be strategically considered to successfully produce and develop designs, systems, models or equipments in projects and organisations (Igbaria and Toraskar, 1992, Tseng *et al.*, 1998, Gottschalk and Khandelwal, 2003, Singare *et al.*, 2005). From this perspective, in the knowledge mapping approach for construction project organisations, construction actors must be used as a knowledge mapping approach component whether it is succeed or not because if a knowledge map is developed without considering the construction actors within construction project organisations the knowledge mapping may be failed (Section 5.3.2.2.3, Section 5.3.4 and Section 5.3.5).

■ Construction process-based

Construction projects consist of a number of processes (Section 2.2.5). Construction processes must be integrated into the knowledge mapping, classifying into different types of processes: generic management system-based processes; and, specific construction work-based processes (Section 5.3.2.2.4).

■ Knowledge transfer technology-focused

In general, technologies provide a number of benefits in developing models, systems, producing products and designing, particularly managing project-based knowledge in the industry (Section 2.2.6). This study has focused on the technologies on knowledge management, particularly knowledge transfer technologies (Section 3.2.5). The knowledge transfer technologies are useful tools for effective project-based knowledge transfer between construction actors and their teams within and across projects and organisations. From this perspective, the knowledge transfer technologies must be considered as a critical knowledge mapping approach component; and, in doing so, the knowledge mapping will be beneficial in transferring project-based knowledge.

6.6 Limitations of research

There are a number of limitations in this study. Above all the things, the key limitations have been derived from to the research methodology adopted for this study.

First, administering how the validity, generalisability and reliability of this study are ensured is difficult due to the research philosophy adopted (Section 4.7). This study does not have enough attempts to assess and evaluate the variables "objectively" and "quantitatively" (Section 4.5 and Section 4.6). In this study, interpretivism was adopted as research philosophy and the case study findings are subjective and qualitative to both the interviewees in the case study company and the researcher. Furthermore, although the caution and attempts were implemented (Section 4.7), the generalisability and replication of the case study findings to a wider population is arguable. Nevertheless, this study provides an important underpinning for future researches on knowledge mapping within construction project organisations, gaining knowledge in depth. The other studies choosing complementary research methodologies which can cover in width are able to have possibilities and opportunities to improve and enhance the findings.

Second, the theory developed in this study was based on investigation of an appropriate knowledge mapping, conducting the case study. However, the case study is based only on a single case study although the case study conducted and sufficiently provided the data and information to develop and propose the theory for successful knowledge mapping within construction project organisations.

6.7 Future research issues

The following research issues are envisaged as worth of the future researches, considering the limitations of this research and research findings.

■ Cross-sector and cross-industry comparison

In this study, the case study provided the findings based on the exploration of a large-sized construction consulting company. Future studies can be performed to explore the relevance of theory in small and large-sized construction consulting companies and general contractor companies. Furthermore, the theory of this study can be also used for future researches to conduct cross-sector and cross-industry comparative studies to extend the scope of generalisability across areas and industries.

■ Larger sample of construction companies

This study reported the findings based on the knowledge mapping within a large construction consulting company, gaining in-depth knowledge for effective project-based knowledge transfer within construction project organisation. The case study findings are still focused on the knowledge mapping in a single case study although this study sought for how appropriate knowledge map can be developed in construction project organisations. Based on this study, future studies can sufficiently explore generalisability of the findings with the other construction companies. With larger and wider samples, extended future researches have more opportunities and potentials to consolidate the theory by the lessons learnt.

6.8 End note

This research has focused on the knowledge mapping approach for effective project performance and project-based learning through construction project-based knowledge transfer between construction actors within construction project organisation (Section 1.4).

In the knowledge map concept model, three key construction project resources identified in the literature review were substantially confirmed (Section 2.2) and a knowledge mapping concept model was articulated (Section 3.2). The case study findings provided evidence to test the concept model (Section 5.3). It was put

forward that construction project organisations have their specific characteristics and knowledge management is not likely to be effectively developed. There are a number of areas left and unexplored although this study examined human resources, process and technologies in the context and attributes of appropriate knowledge mapping approach within construction project organisation. Within this context, this study provided just a step towards an unknown territory. Further significant future researches are looked forward to consolidate the theory of knowledge mapping approach within the other areas.

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Appendices

Appendix A: Interview Co-operation Proposal

http://www.salford.ac.uk

http://hanmiparsons.com/

INTERVIEW CO-OPERATION PROPOSAL

Interview Survey 2006 in HanmiParsons Inc.

Aim and Objective of the Research

The aim of this study is to explore and understand the several issues and clues about how can K-map be developed for effective knowledge transfer in construction projects?

The main objectives are:

- To understand and discuss about what are KM and K-map?
- To debate about your experiences of knowledge transfer.
- To investigate and discuss about how are construction project knowledge transferred in construction projects?
- To explore and discuss about what types of technologies are used and will be applied for knowledge transfer in construction projects?
- To examine and debate about what kind of knowledge has been transferred and will be able to transfer in construction projects?
- To explore about what is construction unit or scope for mapping construction project K-map?

How will the Research be Performed and Conducted?

This study is performed and conducted as the case study of ongoing PhD research project, collaborating with HnamiParsons Inc. A few interviews are implemented and conducted with key construction project members and staffs in a construction project. The number of interviews and interviewees do not clearly decide yet, but each number will be more 5 and each interview will be performed approximately 90minutes.

Introduction of the Case Study Firm for the Interview Survey

HanmiParsons is an expert project and construction management firm that is recognized nationwide for excellence in providing benefit of its Clients. The specialized technical knowledge and broad management ability of HanmiParsons ensures the achievement of desired objectives within time and budget.

Potential Benefits to the Case Study Firm

- Effective and efficient performances construction processes and tasks in projects, transferring Key construction project knowledge effectively.
- More opportunities to systematically manage construction project knowledge.
- Opportunities to design and visualise complex knowledge and structure.
- Effective and efficient opportunities to aid individual and organisational learning by explicitly integrating new and old knowledge.
- Development construction K-map to easily access to relevant knowledge and experts.

Provisions asked to the Case Study Firm

- Discussions more 2 knowledge managers, 2-4 key project managers and more 5-10 project members.
- Access to your company documentations used for the project.
- Each interviewee will be required to provide some information about their basic career and experience.
- Interview transcripts produced by the researcher will be checked by each interviewee.

Considerations on confidentiality

All interviewees' data and information will be strictly managed and the results of interview will be just used for this study.

For more information on this study, please do not hesitate to contact me

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Appendix B: Interview Protocol

University of Salford - SCPM
Interview Survey 2006 in HanmiParsons Inc.

INTRODUCTION

Aim and Objective of the Research

The aim of this interview is to explore and understand the several issues and clues about how can K-map be developed for effective knowledge transfer in construction projects?

The main objectives are:

- To understand and discuss about what are KM and K-map?
- To debate about your experiences of knowledge transfer.
- To investigate and discuss about how are construction project knowledge transferred in construction projects?
- To explore and discuss about what types of technologies are used and will be applied for knowledge transfer in construction projects?
- To examine and debate about what kind of knowledge has been transferred and will be able to transfer in construction projects?
- To explore about what is construction unit or scope for mapping construction project K-map?

Considerations on confidentiality

All interviewees' data and information will be strictly managed and the results of interview will be just used for this study.

Structure of the Protocol

This protocol is divided into two sections:

SECTION A is designed to collect fundamental data and information about interviewees and their company.
SECTION B is organised to efficiently perform the semi-structured interview and to effectively collect knowledge including data and information concerning how is human-based knowledge transferred within construction projects, using knowledge transfer technologies.

If you would like to get any information on this study , please do not hesitate to contact

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Fax: +44 (0) 161 295 5011

SECTION A

This section is basic information about yourself and your company.

■ About you

1. Name:……..……..…..

2. Job Title / Role:……..

3. Education Background:……...

4. Qualifications or Licenses:……...

5. This company experience:……Years

6. Total construction experience: .....Years

7. Telephone No.: ……Fax No.: .....

8. Postal Address:

……

9. Could you please briefly describe your experience concerning construction projects?

……

■ About your company

1. Name of company:……..

2. Number of projects currently undertaken:…….……..

3. Major customers:……..……...

4. Type of projects:……...

5. Established: ……..…… 6. Geographic coverage: .....

7. Turnover per annum: ……8. Trades: ……..……

9. Trade Associations: ……..……

10. Business scope:……...

11. Qualifications/Certifications: ……..

12. Number of permanent staffs: ……..

13. Number of temporary staffs: ……..

14. Telephone No.: …… 15. Fax No.: ……..

16. Postal Address: ……

……

SECTION B

In this section, the semi-structured interview questions are designed interviewees to provide fundamental knowledge about K-map, construction actor-based knowledge and knowledge transfer technologies in order to efficiently perform the interview and collect appropriate data for the research.

■ A. Interview questions to help understanding general knowledge concerning K-map, construction process, construction actor-based knowledge and knowledge transfer technology.

A1. Have you heard or experienced about any K-map?

A11. ***If yes*** could you please describe about it?

A12. ***If no*** the definition, objectives and functions of K-map will be explained by the interviewer.

A2. Do you know what construction processes are…?

A21. ***If yes*** could you please describe about it?

A22. ***If no*** the definition of construction process will be explained by the interviewer.

A3. Do you know what construction actor-based construction knowledge is…?

A31. ***If yes*** could you please describe about it?

A32. ***If no*** the definition of construction actor-based knowledge will be explained by the interviewer.

A4. Do you know what knowledge transfer technology is…?

A41. ***If yes*** could you please describe about it?

A42. ***If no*** the definition of knowledge transfer technology will be explained by the interviewer.

■ B. Interview questions concerning K-map

B1. Do you think K-map is appropriate value or important to perform and accomplish construction projects in your company?

B2. Could you explain how significant is K-map for KM/construction projects in your company?

B3. Which benefits are you or your company likely to gain from K-map?

B4. Who could be the key K-map maker/developer in your company?

B5. What can you consider as the major constraints of K-mapping in your company?

■ C. Interview questions about K-map components: Construction process, construction actor and Knowledge transfer technology.

C1. Considering construction project's components to systematically develop an appropriate K-map for construction knowledge transfer in projects, is it important?

C11. Could you please explain why it is important for K-map?

C12. In your opinion, what are the components of K-map?

C13. Which benefits are you/your company likely to obtain, applying the components of K-map?

C14. What are the major constraints in your company, applying the components of K-map?

C2. Construction process

C21. Do you think construction processes are important to perform and manage construction projects?

C22. How significant are construction processes for construction projects?

C23. Do you think construction processes are appropriate and available as a component of K-map?

C24. In your experience or opinion, what types of construction processes are more important for projects?

C25. In your opinion, why are the processes more important?

C26. What are the standards or considerations in order to decide?

C3. Construction actor

C31. When you were implementing your task in a construction project process have you experienced or felt needs of any knowledge including data and information in order to solve any problem or make any decision?

C32. How did you then gain the knowledge about it? Could you please describe about it?

C32-1. Where did you get the knowledge? From the other staffs or company KMS?

C32-2. What type of knowledge is…? Tacit or explicit knowledge?

C33. Do you think construction actors are important to perform and manage construction projects?

C34. How significant are construction actors for construction projects?

C35. Do you think construction actors are appropriate and available as a component of K-map?

C36. In your experience or opinion, what types of construction actors are more important for projects?

C37. In your opinion, why are the actors more important?

C38. What are the standards or considerations in order to decide?

C4. Construction knowledge transfer technology

C41. When you were implementing your task have you experienced or felt needs of any technology in order to efficiently transfer knowledge in construction projects?

C42. What type of technology did you need or want to use for effectively knowledge transfer? Could you please describe about it?

Q43. What type of knowledge did you want to transfer? Is it tacit or explicit knowledge?

C44. Has your company formally got any technology system or technologies to facilitate and enhance knowledge transfer and sharing between project members on construction sites?

C45. What types of technologies are using for effectively knowledge transfer?

C45-1. Are you satisfied about the system?

C45-2. What type of knowledge is mainly transferred? Is it tacit or explicit knowledge?

C46. Do you think technology is important to transfer knowledge between members in construction projects?

C47. How significant is technology to transfer knowledge between members in construction projects?

C48. Do you think construction knowledge transfer technology is appropriate and available as a component of K-map?

C49. In your experience or opinion, what types of technologies are more important and effective to transfer construction knowledge between members in projects?

C50. In your opinion, why are the technologies more important and effective?

C51. What are the standards or considerations in order to decide?

■ **D. In your experience and opinion, could you provide or propose any examples of unsuccessful K-map to transfer and share knowledge between members in company or project?**

■ **E. Can you envisage or propose some components of K-map for construction knowledge project transfer in projects, such as construction process, knowledge transfer technology, construction actor, construction technology, mobile computing system and construction equipment.**

Thank you for spending your time and your attention

Appendix C: Interview Agreement

INTERVIEW AGGREMENT

This interview will be performed and used for just PhD research by the researcher who is Gang Cheol Yun is studying at PhD course of Research Institute for Built and Human Environment (BuHu) in the University of Salford, Greater Manchester, the UK.

This research which is to explore and propose a theory of K-map for efficient knowledge transfer within construction projects is supervised by Dr Martin Sexton, who can be contacted and reached at m.g.sexton@salford.ac.uk. Therefore, the interview will be conducted, using semi-structured interview questions.

The interview will be strictly managed and kept and will be just used for the research by research students and staffs in academic area.

Please sign this form to show that you have read the contents

Interviewee: (Signed)

Date: .

Appendix D: Basic information of the interviewees

Knowledge manager interviewees

1. Name**: JEP**
2. Job Title / Role: Associate Engineer, Knowledge Creator
3. Education Background: Bachelor of Architectural Engineering
4. Qualifications or Licenses: ……-……
5. This company experience: 0.5 Years
6. Total construction experience: 0.5 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
anmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Knowledge Creator/Generator in Construction/CM/PM

1. Name: **TWK**
2. Job Title / Role: Deputy Manager/Knowledge Manager
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: Registered Construction Engineer, PMP
5. This company experience: 2.5 Years
6. Total construction experience: 2.5 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Knowledge Manager (KMr)

Project member interviewees

1. Name: **HSC**
2. Job Title / Role: Deputy General Manager/Architectural Design
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: Registered Architect
5. This company experience: 3.8 Years
6. Total construction experience: 15.8 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Design in housing building, Design Management in APT.

1. Name: **HWJ**
2. Job Title / Role: Associate Researcher, Site Manager
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: ……-……
5. This company experience: 1.5 Years
6. Total construction experience: 1.5 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Cost management in commercial building ,Contract management in official building

1. Name: **JHO**
2. Job Title / Role: Deputy General Manager/CMr
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: Registered Construction Engineer, Registered Architect
5. This company experience: 7 Years
6. Total construction experience: 11Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Site Manager, Architect, CMr

1. Name**:** **KHL**
2. Job Title / Role: Deputy General Manager
3. Education Background: Bachelor of Electrical Engineering
4. Qualifications or Licenses: Registered Electrical Engineer
5. This company experience: 7 Years
6. Total construction experience: 15 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Great Channel Project in Libya, Ulgin Atomic Energy Station Project in Korea, ASEM Project in Korea, Shinsegae Department Store in Korea.

1. Name: **KTK**
2. Job Title / Role: Principle Engineer
3. Education Background: Bachelor of Architectural Engineering
4. Qualifications or Licenses: PMP, Registered Construction Engineer
5. This company experience: 2 Years
6. Total construction experience: 10 Years

7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
E-business Management in HanmiParsons Co., Ltd., Master plan in ASEM Building in Korea, Plaza Rakyat Project in Malaysia.

1. Name: **WKC**
2. Job Title / Role: Deputy General Manager/Human Resource Department
3. Education Background: Bachelor of HRM
4. Qualifications or Licenses: Registered Construction Health and Safety Engineer
5. This company experience: 6 Years
6. Total construction experience: 16 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
HRM & HRD in Construction Company, Organisation Culture Management for KM

Project manager interviewees

1. Name: **KIK**
2. Job Title / Role: Senior Managing Director/PM
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: PMP, Registered Construction Engineer
5. This company experience: 10 Years
6. Total construction experience: 23 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Quality Management in Atomic Energy Station Projec Korea, Qulaity Management in Oil Plant Project Of Libya, PM in Broadcasting Station Project in Korea, PM in Samsung Tesco Project of Korea.

1. Name: **KNK**
2. Job Title / Role: Senior Director
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: Registered Architect, Registered Construction Engineer
5. This company experience: 9 Years
6. Total construction experience: 23 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:

HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Hofuf Housing Project (Saudi Arabia), Dabble Bay Condomium Project (Singapore), Schedule Management, Cost Management.

1. Name: **SSK**
2. Job Title / Role: Managing Director
3. Education Background: Bachelor of Architectural Engineering
4. Qualifications or Licenses: PMP, Registered Construction Engineer
5. This company experience: 10 Years
6. Total construction experience: 20 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
CM of Tower Palace Project in Korea, CM of Shinsegae Department Store Project in Korea, The Greater Water Channel Project in Libya.

1. Name**: OGK**
2. Job Title / Role: Senior Managing Director/PM
3. Education Background: Master of Architectural Engineering
4. Qualifications or Licenses: PMP, Registered Construction Engineer
5. This company experience: 9Years
6. Total construction experience: 23 Years
7. Telephone No.: (00)82-031-719-5125 Fax No.: (00)82-031-719-5127
8. Postal Address:
HanmiParsons Co., Ltd.
9th Fl. City Air Tower Bldg. 159-9,
Samsung-dong, Kangnam-gu, Seoul,
135-090,
Korea
9. Could you please briefly describe your experience concerning construction projects?
Cost Management in Oil Plant Project Of Libya, Project manager in Broadcasting Station Project in Korea, structural designer in Samsung Tesco Project of Korea.

Appendix E: A representative sample of verbatim interview transcript (Knowledge Manager)

SECTION A

This section is basic information about yourself and your company.

■ About you

1. Name: **Tae Wan Kim**

2. Job Title / Role: Deputy Manager/Knowledge Manager

3. Education Background: Master of Architectural Engineering

4. Qualifications or Licenses: Registered Construction Engineer, PMP

5. This company experience: 2.5 Years

6. Total construction experience: 2.5 Years

7. Telephone No.: (00)82-031-xxx-xxxx Fax No.: (00)82-031-xxx-xxxx

8. Postal Address:

HanmiParsons Co., Ltd.

9th Fl. City Air Tower Bldg. 159-9,

Samsung-dong, Kangnam-gu, Seoul,

135-090,

Korea

9. Could you please briefly describe your experience concerning construction projects?

Knowledge Manager (KMr)

■ About your company

1. Name of company: HanmiParsons Co., Ltd.

2. Number of projects currently undertaken: 90 Projects

3. Major customers:

Organisations in Private Sector, Organisations in Public Sectors,

Ministries of Korean Government, Multinational Enterprises, Universities…etc

4. Type of projects:

High Rise Buildings, Residential Complex, Official Buildings, Commercial Buildings,

SOC/Infrastructure, Remodeling Projects, Industrial Facilities, Education/Cultural

Facilities, Sports Facilities, Medical Facilities, Tourist Facilities, Religious Facilities,

Housings…etc

5. Established: 1996 Year 6. Geographic coverage: Global

7. Turnover per annum: 45 Million Pounds

8. Trades:

Project Management (PM), Construction Management (CM),

Project Financing Assistance (PFA), Property Management

9. Trade Associations:

Morgan Stanley, Kookmin Bank, Korea National Housing Corporation, National Tax

Administration, Busan New Port Co., Ltd., Samsung Heavy Industries, Samsung TESCO, Samsung Electronics, Seoul Municipal Government, Suwon City Government, Hyundai Development, Hilton Hotel, Posco Development, British American Tobacco, Canadian Embassy, Sungkyunkwan University….etc

10. Business scope: From Planning to Maintenance in Construction Industry

11. Qualifications/Certifications:

Architect (300), Registered Construction Engineer (140),

Registered Architectural Designer (25), PMP (10)

12. Number of permanent staffs: 342 Staffs

13. Number of temporary staffs: 13 Staffs

14. Telephone No.: (00)82-(0)2-3429-6300 15. Fax No.: (00)82-(0)2-3429-6363

15. Postal Address:

HanmiParsons Co., Ltd.

9th Fl. City Air Tower Bldg. 159-9,

Samsung-dong, Kangnam-gu,

Seoul,

135-090,

Korea

SECTION B

In this section, the semi-structured interview questions are designed interviewees to provide fundamental knowledge about K-map, construction actor-based knowledge and knowledge transfer technologies in order to efficiently perform the interview and collect appropriate data for the research.

■ A. Interview questions to help understanding general knowledge concerning K-map, construction process, construction actor-based knowledge and knowledge transfer technology.

A1. Have you heard or experienced about any K-map?

A11. *If yes* could you please describe about it?

A: K-map? Urrr~~. Do you think it is same meaning as the K-map in KM.

Q: Yes I do.

A: If so I know about. I mean we are using K-map for KM.

A12. *If no* the definition, objectives and functions of K-map will be explained by the interviewer.

A2. Do you know what construction processes are…?

A21. *If yes* could you please describe about it?

A: Of course, I do.

A22. *If no* the definition of construction process will be explained by the interviewer.

A3. Do you know what construction actor-based construction knowledge is…?

A31. *If yes* could you please describe about it?

A: Does the knowledge mean tacit knowledge? Why is the actor-based knowledge? Is it different to construction knowledge?

Q: Well~~~. Firstly, the knowledge means both of them, tacit and explicit knowledge, and the knowledge is owned by construction actors, so it contains all of knowledge including data and information. Of course, construction-related knowledge is contained in the construction actor-based knowledge or involves the construction actor-based knowledge. I mean in the construction knowledge area, the knowledge is owned and deeply managed by construction actors for construction project.

A: Is it different to organisational knowledge.

Q: Yes it is.

A: I see…I see.

A32. *If no* the definition of construction actor-based knowledge will be explained by the interviewer.

A4. Do you know what knowledge transfer technology is…?

A41. ***If yes*** could you please describe about it?

A: Something is for sharing and transferring knowledge for and in project, isn't it?

Q: Yes it is.

A42. *If no* the definition of knowledge transfer technology will be explained by the interviewer.

■ B. Interview questions concerning K-map

B1. Do you think K-map is appropriate value or important to perform and accomplish construction projects in your company?

A: we are now using a K-map for KM. I think it of course needs to build and develop KM.

Q: Did you develop the K-map?

A: No I didn't. It was made by some construction actors about 5years ago, but I think the K-map was developed by poor and wrong concept and strategy. I mean although the K-map was developed by a taskforce team it did not have study or

considerations related to any concept, components, strategy and the other things. Therefore, our KM has big problem about upgrade, update, store and classification of knowledge and compatibility with installing PMIS, Expert System, PDA or Mobile Phone. I think it should be redeveloped as soon as possible.

Q: So, do you think it is appropriate?

A: Of course, yes I do.

B2. Could you explain how significant is K-map for KM/construction projects in your company?

A: Now we have a K-map and we are upgrading it, but once it was made by wrong method I for example mean…. without considering objective, strategy, components, upgrade, update, compatibility and the other things of K-map or KM… as has been mentioned above, our KM has thus got many problems. Therefore, K-map should definitely be researched and considered for effective KM.

B3. Which benefits are you or your company likely to gain from K-map?

A: Basically, this I have heard from my colleagues is a story concerning K-map project performed 5 years ago before I am employed. I have heard about K-map and KM of our company. Basically, if somebody wants to build a KM he/she should study and consider about K-map because K-map is a cornerstone of KM and it is necessary for KM. However, in this case, KMS of our company was outsourced and delivered by a system development company which does not know what construction industry and project are. The company thus just wanted to get a K-map in order to develop a KMS, but the company did not try to talk about importance of K-map because it is very difficult and if a complicate K-map is made developing and constructing KMS is very hard and expensive. Therefore, they did not want to get a complicate K-map and our company's KMS was made without considering the appropriate K-map. That is problem. As a result of the outsourcing KMS, wrong K-map was applied and poor KMS was constructed. As has been mentioned above, K-map is one of the most important components and KMS built by applying and considering an appropriate K-map is effective to more quickly and easily looking for right knowledge at the right time from right K-owner. Also, upgrading or updating can be more easily and quickly conducted and ultimately cost and time would be reduced and quality may be improved.

Q: Thank you.

B4. Who could be the key K-map maker/developer in your company?

A: Firstly, I think a taskforce team should be organised, and then concept, objective and strategy of K-map are made and regulated, after that, a basic model should be made by a construction actor group in which construction professionals are involved, and then the other departments of company, such as system development team or human resource department, should be joined in the project in order to apply and add the other ideas or items. Finally, CKO, K-map developer or KMr should organise and design.

Q: How can the basic model be made?

A: I think something is needed to effectively develop the model because models are generally composed of various components which would be important factors for construction projects. Therefore, it is very important to know what the components of K-map for construction project are. That is it.

B5. What can you consider as the major constraints of K-mapping in your company?

A: Firstly, I think weak and poor knowledge sharing culture is one of the constraints and shortage of professional knowledge and theory, such as definition,, objective, strategy, function and kind of K-map is the second one. Also, shortage of professional training and human resource is the final one. This is just my opinion. Of course, cost and time are decided by leadership of CEO.

Q: Do you think leadership of CEO is the most important constraint.

A: Umum~~ Yes, could be~~ because if CEO say "No" about any project it can not be performed anything.

■ C. Interview questions about K-map components: Construction process, construction actor and Knowledge transfer technology.

C1. Considering construction project's components to systematically develop an appropriate K-map for construction knowledge transfer in projects, is it important?

A: Yes it is because the construction industry has got specific characteristics, time and cost limited by project schedule and budget, quality regulated by regulation and specification, always different site, actors and organisations…always different geographical conditions. That is it.

C11. Could you please explain why it is important for K-map?

A: As has been mentioned above, a construction project has a lot of general and specific characteristics and it is deeply related and is interacted each other. Also, too many elements of construction are conglomerated in a project. Therefore, some components should be selected and applied to construction K-map development project and selecting and applying some components of K-map would contribute and suggest a direction for effective K-map development plan.

C12. In your opinion, what are the components of K-map?

A: Hum~~~. Firstly, construction actor and process are definitely necessary and for effective KM, knowledge content may be one…. Business or project type…could be… Ye..Ye. That is it.

C13. Which benefits are you/your company likely to obtain, applying the components of K-map?

A: Firstly, time and cost reduction throughout effective management about new system upgrading and new knowledge updating and secondly, improvement of ability of company staffs. Competitiveness of company may be improved …..

C14. What are the major constraints in your company, applying the components of K-map?

A: As has been mentioned above, the biggest constraint is shortage of interest/leadership of CEO because CEO decides cost and time of K-map development project and secondly, in the immature knowledge sharing culture, the importance of KM and K-map is not recognised by company members. Shortage of professional human resource and training is the final constraint. I think so.

C2. Construction process

C21. Do you think construction processes are important to perform and manage construction projects?

A: Of course, it is important because the processes are to organise and compose of construction project. We are now developing a CDP (Career Development Process) because of importance of construction process. In the CDP, individuals are managed and improved their professional ability by each type of occupation of construction CDP is ultimately to cultivate various professional expert in each construction process.

C22. How significant are construction processes for construction projects?

A: As has been mentioned, I think it is all of construction.

C23. Do you think construction processes are appropriate and available as a component of K-map?

A: Of course.

C24. In your experience or opinion, what types of construction processes are more important for projects?

A: In my opinion, all of them may be important. I am sorry I have not worked in project. However, I know every process is important

C25. In your opinion, why are the processes more important?

A: I said all of them are important.

C26. What are the standards or considerations in order to decide?

A: I do not need answer.

C3. Construction actor

C31. When you were implementing your task in a construction project process have you experienced or felt needs of any knowledge including data and information in order to solve any problem or make any decision?

A: Yes I have.

C32. How did you then gain the knowledge about it? Could you please describe about it?

A: Naver…um~~ I like using the internet and sometimes I used to use mobile phone MSN messenger. And when I receive data or information from my friends or colleagues I use e-mail.

C32-1. Where did you get the knowledge? From the other staffs or company KMS?

A: Generally, I like using mobile phone. Ah!! You know I do not need to get construction knowledge because my task is to manage knowledge in this company. So, I just need knowledge about KM or …um um ..K-map…. You know what I mean.

Q: I know.

C32-2. What type of knowledge is…? Tacit or explicit knowledge?

A: Almost all knowledge is both of them.

C33. Do you think construction actors are important to perform and manage construction projects?

A: I think it is very much important.

C34. How significant are construction actors for construction projects?

A: Absolutely.

C35. Do you think construction actors are appropriate and available as a component of K-map?

A: Yes I do.

C36. In your experience or opinion, what types of construction actors are more important for projects?

A: Do you mean on the KM side.

Q: Yes.
Q: I think it is on the effective side. So, who are the effective actors for construction project? May be PMr…..could be.

A: Only PMr…?

Q: I mean it is the people who have knowledge, know-how, experience, insight and the other high level knowledge about construction project processes, such as PMr.

C37. In your opinion, why are the actors more important?

A: Because almost all construction workers are controlled and deployed by company system and regulation. Therefore, some people who manage and control the company system and regulation in project are important.

C38. What are the standards or considerations in order to decide?

A: Because they manage and organise the project team and construction processes and they can decide some core issues in project. Also, they have a lot of

knowledge, know-how, experience and item concerning construction project in their job experience.

C4. Construction knowledge transfer technology

C41. When you were implementing your task have you experienced or felt needs of any technology in order to efficiently transfer knowledge in construction projects?

A: Yes.

C42. What type of technology did you need or want to use for effectively knowledge transfer? Could you please describe about it?

A: Mobile phone, MSN and E-mail. That is all.

Q43. What type of knowledge did you want to transfer? Is it tacit or explicit knowledge?

A: In my case, I was both of them.

C44. Has your company formally got any technology system or technologies to facilitate and enhance knowledge transfer and sharing between project members on construction sites?

A: I do not know clearly. KMS and Q&A system could be…

C45. What types of technologies are using for effectively knowledge transfer?

A: KMS and Q&A system, e-mail…… That is all.

C45-1. Are you satisfied about the system?

A: I am not satisfied.

C45-2. What type of knowledge is mainly transferred? Is it tacit or explicit knowledge?

A: In my case, I was both of them.

C46. Do you think technology is important to transfer knowledge between members in construction projects?

A: Yes it is very important. I think using the technology could be cost effectiveness, but company members do not care about cost effectiveness because

they do not like using the new technology, training and studying about the technology. That is it.

C47. How significant is technology to transfer knowledge between members in construction projects?

A: I think very much.

C48. Do you think construction knowledge transfer technology is appropriate and available as a component of K-map?

A: I think yes.

C49. In your experience or opinion, what types of technologies are more important and effective to transfer construction knowledge between members in projects?

A: I think we ultimately need to use mobile technology system because of mobility, effectiveness, accessibility and utility, installing KMS, RFID, PMIS and Expert System.

C50. In your opinion, why are the technologies more important and effective?

A: I think because of mobility, effectiveness, accessibility and utility, installing KMS, RFID, PMIS and Expert System.

C51. What are the standards or considerations in order to decide?

A: Um~~~. Practicability, mobility and utility…speed. Ultimately it could be related to cost and time.

■ **D. In your experience and opinion, could you provide or propose any examples of unsuccessful K-map to transfer and share knowledge between members in company or project?**

A: In my experience, this company is an example. In this company, A K-map developed without considering strategy, objective, components and the others of KM and K-map was developed and company KMS was not systematically considered the compatibility to PMIS, Expert System and the other computing systems. Also in the k-map, knowledge sorting system was made ineffectively. Due to this reason, people waste too much time in order to get the right knowledge. In conclusion, classification method of knowledge is very important. I think K-map can be used applied effectively.
And I think enough time and cost should be gained for K-mapping.

■ **E. Can you envisage or propose some components of K-map for construction knowledge project transfer in projects, such as construction process, knowledge transfer technology, construction actor, construction technology, mobile computing system and construction equipment.**

A: I think business/project type can be a component of K-map because in the construction industry, many types of projects have been performing, for example High Rise Buildings, Residential Complex, Official Buildings, Commercial Buildings, SOC/Infrastructure, Remodeling Projects, Industrial Facilities, Education/Cultural Facilities, Sports Facilities, Medical Facilities, Tourist Facilities, Religious Facilities, Housings…etc and they are related to and used different construction actors, processes, equipments and works…. Therefore, according to project type, K-map should be developed. I think so.

Thank you for spending your time and your attention

Appendix F: A representative sample of verbatim interview transcript (Project Manager)

SECTION A

This section is basic information about yourself and your company.

■ About you

1. Name**: KIK**

2. Job Title / Role: Senior Managing Director/PM

3. Education Background: Master of Architectural Engineering

4. Qualifications or Licenses: PMP, Registered Construction Engineer

5. This company experience: 10 Years

6. Total construction experience: 23 Years

7. Telephone No.: (00)82-031-xxx-xxxx Fax No.: (00)82-031-xxx-xxxx

8. Postal Address:

HanmiParsons Co., Ltd.

9th Fl. City Air Tower Bldg. 159-9,

Samsung-dong, Kangnam-gu, Seoul,

135-090,

Korea

9. Could you please briefly describe your experience concerning construction projects?

Quality Management in Atomic Energy Station Projec Korea,

Qulaity Management in Oil Plant Project Of Libya,

PM in Broadcasting Station Project in Korea,

PM in Samsung Tesco Project of Korea.

■ About your company

1. Name of company: HanmiParsons Co., Ltd.

2. Number of projects currently undertaken: 90 Projects

3. Major customers:

Organisations in Private Sector, Organisations in Public Sectors,

Ministries of Korean Government, Multinational Enterprises, Universities…etc

4. Type of projects:

High Rise Buildings, Residential Complex, Official Buildings, Commercial Buildings,

SOC/Infrastructure, Remodeling Projects, Industrial Facilities, Education/Cultural

Facilities, Sports Facilities, Medical Facilities, Tourist Facilities, Religious Facilities,

Housings…etc

5. Established: 1996 Year 6. Geographic coverage: Global

7. Turnover per annum: 45 Million Pounds

8. Trades:

Project Management (PM), Construction Management (CM),

Project Financing Assistance (PFA)

9. Trade Associations:

Morgan Stanley, Kookmin Bank, Korea National Housing Corporation, National Tax

Administration, Busan New Port Co., Ltd., Samsung Heavy Industries, Samsung TESCO, Samsung Electronics, Seoul Municipal Government, Suwon City Government, Hyundai Development, Hilton Hotel, Posco Development, British American Tobacco, Canadian Embassy, Sungkyunkwan University….etc

10. Business scope: From Planning to Maintenance in Construction Industry

11. Qualifications/Certifications:

Architect (300), Registered Construction Engineer (140),

Registered Architectural Designer (25), PMP (10)

12. Number of permanent staffs: 342 Staffs

13. Number of temporary staffs: 13 Staffs

14. Telephone No.: (00)82-(0)2-3429-xxxx 5. Fax No.: (00)82-(0)2-3429-xxxx

15. Postal Address:

HanmiParsons Co., Ltd.

9th Fl. City Air Tower Bldg. 159-9,

Samsung-dong, Kangnam-gu,

Seoul,

135-090,

Korea

SECTION B

In this section, the semi-structured interview questions are designed interviewees to provide fundamental knowledge about K-map, construction actor-based knowledge and knowledge transfer technologies in order to efficiently perform the interview and collect appropriate data for the research.

■ A. Interview questions to help understanding general knowledge concerning K-map, construction process, construction actor-based knowledge and knowledge transfer technology.

A1. Have you heard or experienced about any K-map?

A11. *If yes* could you please describe about it?

A: I have heard and experienced, but I do not know clearly.

A12. *If no* the definition, objectives and functions of K-map will be explained by the interviewer.

(Definition, function and the others of K-map are explained by the interviewer)

Q: Can you understand the meaning of K-map clearly.

A: Yes I can.

A2. Do you know what construction processes are…?

A21. ***If yes*** could you please describe about it?

A : Hahahahaha~~~. Mr Yun, you know I know, aren't you.

Q: Yes I am. I am sorry.

A22. ***If no*** the definition of construction process will be explained by the interviewer.

A3. Do you know what construction actor-based construction knowledge is…?

A31. ***If yes*** could you please describe about it?

A: I know about it. Do you mean human-based knowledge in construction project, don't you?

Q: Yes I do.
A: I think the knowledge is owned and accumulated by people and they related to job experience, insight, brain…know-how. Also, it is very difficult to codify and store in to text, picture, table, number…and symbol.

Q: Um~~. I think you just think tacit knowledge, but explicit knowledge is also contained in construction actor-based knowledge. You know what I mean?

A: Yes, I do.

A32. ***If no*** the definition of construction actor-based knowledge will be explained by the interviewer.

A4. Do you know what knowledge transfer technology is…?

A41. *If yes* could you please describe about it?

A42. *If no* the definition of knowledge transfer technology will be explained by the interviewer.

A : I do not know clearly. Mr Yun, could you explain about it?

(The interviewer is explaining about it)

Q: Do you understand about it, Sir.

A: Yes I do. Thank you.

■ B. Interview questions concerning K-map

B1. Do you think K-map is appropriate value or important to perform and accomplish construction projects in your company?

A: Um~~~. So… I think K-map should be made by occupation. Of course that has appropriate value. I know K-map is very important. So I have already made K-map for me.

Q: Ah~~~. Did you make the K-map?

A: Yes I did. In my K-map, each construction process is explained as a node by Folder. In the Folder, much data and information are organised in order by me, but almost all of them are explicit knowledge.

Q: In your K-map, how did you organise construction processes. I mean…umum..

A: I know you mean. I have worked and experienced Atomic Energy Station Project and oil plant project in overseas. Therefore, I know about construction process and I used and applied simple process for the K-map. I think K-map should be as simple as possible.

B2. Could you explain how significant is K-map for KM/construction projects in your company?

A: In short, if K-map is effective built according to construction process or procedure knowledge will be managed and K-users would be more easily able to find out and gain appropriate knowledge for their problem and trouble. That is it.

B3. Which benefits are you or your company likely to gain from K-map?

A: The company may have a lot of benefits. The benefits would be comprehensive .. to cost, time, quality, confidence, competitiveness….

B4. Who could be the key K-map maker/developer in your company?

A: Anyway, K-am development project should be managed a K-map specialist and all of professionals related to project type, business model and construction process should be jointed in the K-map development project because a construction project is very complicated and is related to many people and processes. Therefore, in order to effectively build a K-map, various construction experts by occupation have to take part in the project according to strategy and objective of KM and K-map.

B5. What can you consider as the major constraints of K-mapping in your company?

A: Firstly, will and leadership of CEO are the most important and interest and concern of organisation members as well. I think leadership of CEO, know-how, interest and concern of members, experience and skill…and the others, all of them need and are integrated in order to develop and make … You know what I mean?

Q: I know you mean.

■ C. Interview questions about K-map components: Construction process, construction actor and Knowledge transfer technology.

C1. Considering construction project's components to systematically develop an appropriate K-map for construction knowledge transfer in projects, is it important?

A: Do you mean transfer technology is for sharing or diffusion? And in the process, I think the content of knowledge should be classified into construction work-based knowledge and construction management-based knowledge. Because I think the process is just likely to be recognised as a too comprehensive factor. I mean the process should be sorted out and classified in detail on the K-mapping side. In my opinion, some components should of course be considered.

C11. Could you please explain why it is important for K-map?

A: As has been mentioned above, construction projects are always related and connected to the other factors, people, procedure, manual, guide book, regulation and law, equipment, technology and …and they are interacted and influenced each other. Therefore, some components should be selected and applied for effectively developing a construction K-map because you know … all of them can not be applied or selected for the map. Also, it is very important and difficult to find out appropriate components for the K-map.

C12. In your opinion, what are the components of K-map?

A: I think in this point, construction process should really be divided into two parts. I mean … into construction work process and construction management process because maybe you know management systems, such as cost management, quality management, time management and the other management systems, are not involved in construction work process. I think management process is totally different part as compared with construction work process. Also construction actor would be a component of K-map because all of works, systems, plans, managements and others are always performed by actors, such as architect, CMr, PMr, QS, construction structure engineer, construction engineer… construction

Q: What do you think about construction equipment, as a factor?

A: I think construction equipment can be a component of K-map, but it could be too complicated and difficult because too many types of equipment are generally related and used for construction works. Also, construction equipment-related knowledge is more related to sub-contractors than general contractor or CM/PM

consulting company. Therefore, I think the equipment would not be a appropriate component of K-map. This is my opinion.

C13. Which benefits are you/your company likely to obtain, applying the components of K-map?

A: Firstly, organisation members' knowledge is increased and their ability can be improved. Also, organisation's confidence and competitiveness would be increased. Company's benefit could increase with the advantages. Furthermore, if a construction actor-based K-map is constructed organisation and individual training for members would be decreased. As a result of, company members can gain much knowledge without outsourcing and in-house training. Cost and time can thus be reduced.

C14. What are the major constraints in your company, applying the components of K-map?

A: As has been mentioned, could be… leadership of CEO and interest and concern of organisation members and K-map specialist.

C2. Construction process

C21. Do you think construction processes are important to perform and manage construction projects?

A: Of course, Yes. I think process is a cell as compared with human's body. If process is not implemented or managed project would be failed or delayed. So process is important.

C22. How significant are construction processes for construction projects?

A: Very much.

C23. Do you think construction processes are appropriate and available as a component of K-map?

A: Of course, yes. It is core of K-map.

C24. In your experience or opinion, what types of construction processes are more important for projects?

A: I think all of the processes are equally important. All of them should thus be contained in a construction K-map. However, some processes can be more easily

accessed to K-map. So, K-amp should be firstly accessed to the processes because of effectiveness. I think so.

C25. In your opinion, why are the processes more important?

A: As has been mentioned above, all of the processes are equally important because construction project is a continuum of processes and they have to perform in regular sequence.

C26. What are the standards or considerations in order to decide?

A: I said that all of the processes are important.

C3. Construction actor

C31. When you were implementing your task in a construction project process have you experienced or felt needs of any knowledge including data and information in order to solve any problem or make any decision?

A: Yes I have too much time.

C32. How did you then gain the knowledge about it? Could you please describe about it?

A: Commonly, I firstly contact to my friends or colleagues, having a phone call after that I receive some data or information by the e-mail. Therefore, I think relationship is very important factor to gain and share knowledge including data and information. I do not like using KMS or the internet and messenger because the KMS is not good for me and in the internet, knowledge is too comprehensive and MSN messenger is too difficult to use. That is it.

C32-1. Where did you get the knowledge? From the other staffs or company KMS?

A: I have firstly gained from my friends and colleagues, having communication on a phone call.

Q: In your company or out of company?

A: Firstly, in my company. After that, out of company.

C32-2. What type of knowledge is…? Tacit or explicit knowledge?

A: Almost all of them are very important knowledge, but it is not tacit knowledge because tacit knowledge can not be commonly codified or is difficult to express into explicit knowledge.

C33. Do you think construction actors are important to perform and manage construction projects?

A: Of course, Yes. Our company has got problem with HRM/HRD. Good human resource is power of company because people are at the heart of KM and project. Especially, knowledge intensive companies like our company think and believe human resource is core asset of enterprise.

C34. How significant are construction actors for construction projects?

A: I think very much.

C35. Do you think construction actors are appropriate and available as a component of K-map?

A: Of course yes, but maybe some people are not important, such as operatives, foreman, carpenter, plumber, electrician, operator or driver of construction equipment and vehicle, and the other people

C36. In your experience or opinion, what types of construction actors are more important for projects?

A: Um um um…as has been mentioned above, all of them are important, but in order to develop K-map, some core construction actors should be selected. I think the people can be selected project type or service and project contract type.

C37. In your opinion, why are the actors more important?

A: I have already said.

C38. What are the standards or considerations in order to decide?

A: I have already answered for it above.

<u>C4. Construction knowledge transfer technology</u>

C41. When you were implementing your task have you experienced or felt needs of any technology in order to efficiently transfer knowledge in construction projects?

A: Yes.

C42. What type of technology did you need or want to use for effectively knowledge transfer? Could you please describe about it?

A: Mobile phone and e-mail.

Q43. What type of knowledge did you want to transfer? Is it tacit or explicit knowledge?

A: Almost all of them are explicit knowledge.

C44. Has your company formally got any technology system or technologies to facilitate and enhance knowledge transfer and sharing between project members on construction sites?

A: Yes, KMS, Q&A system and expert system.

C45. What types of technologies are using for effectively knowledge transfer?

A: As has been mentioned above, KMS, Mobile phone, e-mail and the internet..

C45-1. Are you satisfied about the system?

A: Yes, I do not have any complaints because I have already got much knowledge in my K-map. So I am OK.

C45-2. What type of knowledge is mainly transferred? Is it tacit or explicit knowledge?

A: Almost all were explicit knowledge.

C46. Do you think technology is important to transfer knowledge between members in construction projects?

A: I think technology needs. If technology is not construction knowledge would not be transferred because of specific characteristics of construction industry. I mean construction actors do not like sharing knowledge.

C47. How significant is technology to transfer knowledge between members in construction projects?

A: It is very important. As has been mentioned above, people think knowledge like know-how, insight and experience, is competitiveness. They do not like sharing and transferring.

C48. Do you think construction knowledge transfer technology is appropriate and available as a component of K-map?

A: I think it is appropriate as a component of K-map. It could be a tool in order to transfer construction knowledge.

C49. In your experience or opinion, what types of technologies are more important and effective to transfer construction knowledge between members in projects?

A: I think mobile phone could be possible as an explicit knowledge transfer technology, installing PMIS in big construction project and KMS may be more effective in the situation. Because in the construction site, more clear and deed knowledge is needed, such as problem solving knowledge. So in order to solve such problems, experience and know-how are more needed than just information or data. Therefore, sorting list of construction actors is very effective.

Q: If you think so if your company has got any list of company members in which the members are classified and organised according to job title/role, experienced project type or size, speciality and the other features do you think the list is effective?

A: I think it is very effective, but classification method is important.

C50. In your opinion, why are the technologies more important and effective?

A: Because knowledge is faster and easier transferred and shared.

C51. What are the standards or considerations in order to decide?

A: As has been said above, high level knowledge is not transferred and shared. If company has thus got a formal system for knowledge sharing, organisation members would be used.

■ **D. In your experience and opinion, could you provide or propose any examples of unsuccessful K-map to transfer and share knowledge between members in company or project?**

A: I am sorry. I have no idea.

■ **E. Can you envisage or propose some components of K-map for construction knowledge project transfer in projects, such as construction**

process, knowledge transfer technology, construction actor, construction technology, mobile computing system and construction equipment.

A: Do you mean that I just have to talk about K-map.

Q: Yes.

A: I think the question is ambiguous. I should select something in the example.

Q: No no.. You can do in you mind.

A: Um …. The most important point is that any technologies for tacit knowledge sharing and transfer firstly have to be developed. However, I do not what the technologies are. Maybe people like you have to. I am sorry…

Thank you for spending your time and your attention

Appendix G: A representative sample of verbatim interview transcript (Project Member)

SECTION A

This section is basic information about yourself and your company.

■ About you

1. Name: **JHO**

2. Job Title / Role: Deputy General Manager/CMr

3. Education Background: Master of Architectural Engineering

4. Qualifications or Licenses: Registered Construction Engineer, Registered Architect

5. This company experience: 7 Years

6. Total construction experience: 11Years

7. Telephone No.: (00)82-031-xxx-xxxx Fax No.: (00)82-031-xxx-xxxx

8. Postal Address:

HanmiParsons Co., Ltd.

9th Fl. City Air Tower Bldg. 159-9,

Samsung-dong, Kangnam-gu, Seoul,

135-090,

Korea

9. Could you please briefly describe your experience concerning construction projects?

Site Manager, Architect, CMr

■ About your company

1. Name of company: HanmiParsons Co., Ltd.

2. Number of projects currently undertaken: 90 Projects

3. Major customers:

Organisations in Private Sector, Organisations in Public Sectors,

Ministries of Korean Government, Multinational Enterprises, Universities…etc

4. Type of projects:

High Rise Buildings, Residential Complex, Official Buildings, Commercial Buildings,SOC/Infrastructure, Remodeling Projects, Industrial Facilities, Education/Cultural Facilities, Sports Facilities, Medical Facilities, Tourist Facilities, Religious Facilities, Housings…etc

5. Established: 1996 Year 6. Geographic coverage: Global

7. Turnover per annum: 45 Million Pounds

8. Trades:

Project Management (PM), Construction Management (CM),

Project Financing Assistance (PFA), Property Management

9. Trade Associations:

Morgan Stanley, Kookmin Bank, Korea National Housing Corporation, National Tax Administration, Busan New Port Co., Ltd., Samsung Heavy Industries, Samsung TESCO, Samsung Electronics, Seoul Municipal Government, Suwon City Government, Hyundai Development, Hilton Hotel, Posco Development, British American Tobacco, Canadian Embassy, Sungkyunkwan University….etc

10. Business scope: From Planning to Maintenance in Construction Industry

11. Qualifications/Certifications:

Architect (300), Registered Construction Engineer (140), Registered Architectural Designer (25), PMP (10)

12. Number of permanent staffs: 342 Staffs

13. Number of temporary staffs: 13 Staffs

14. Telephone No.: (00)82-(0)2-3429-xxxx 15. Fax No.: (00)82-(0)2-3429-xxxx

15. Postal Address:

HanmiParsons Co., Ltd.

9th Fl. City Air Tower Bldg. 159-9,

Samsung-dong, Kangnam-gu,

Seoul,

135-090,

Korea

SECTION B

In this section, the semi-structured interview questions are designed interviewees to provide fundamental knowledge about K-map, construction actor-based knowledge and knowledge transfer technologies in order to efficiently perform the interview and collect appropriate data for the research.

■ A. Interview questions to help understanding general knowledge concerning K-map, construction process, construction actor-based knowledge and knowledge transfer technology.

A1. Have you heard or experienced about any K-map?

A11. *If yes* could you please describe about it?

A12. *If no* the definition, objectives and functions of K-map will be explained by the interviewer.

A: Is K-map different area to KM? If so how sis it different?

Q: The meaning is different, but K-map is a cornerstone and prerequisite of KM and K-map is to visualise and express knowledge resources and artefacts and relationships and interactions between them for KM. Do you understand about it.

A: Yes I do.

A2. Do you know what construction processes are…?

A21. *If yes* could you please describe about it?

A: Of course, I do.

A22. *If no* the definition of construction process will be explained by the interviewer.

A3. Do you know what construction actor-based construction knowledge is…?

A31. *If yes* could you please describe about it?

A: Yes I do.

A32. *If no* the definition of construction actor-based knowledge will be explained by the interviewer.

A4. Do you know what knowledge transfer technology is…?

A41. ***If yes*** could you please describe about it?

A42. *If no* the definition of knowledge transfer technology will be explained by the interviewer.

A: I do not know clearly.

(The meaning is explained by the interviewer)

Q: Can you understand about it?

A: yes I can. For example KMS, Q&A system, Messenger, Expert system…Are you OK.

Q: Yes it is enough

■ B. Interview questions concerning K-map

B1. Do you think K-map is appropriate value or important to perform and accomplish construction projects in your company?

A: Yes, of course I think so.

B2. Could you explain how significant is K-map for KM/construction projects in your company?

A: I think if a K-map is effectively constructed by any K-map specialists knowledge is generated and rejected according to KMS built by the K-map. Good quality knowledge is thus managed and shared continuously. I think this is important point.

B3. Which benefits are you or your company likely to gain from K-map?

A: I think constructability is improved. Appropriate knowledge is more effectively transferred and shared throughout KM or K-map and if the knowledge

is applied to construction or business performances on the construction site, constructability would of course be increased and improved. Moreover, cost and competitiveness are reduced and improved and due to these reasons, company benefit would be increased.

Q: Personally, what benefits are you likely to have?

A: In my opinion, I think my tasks would be easier and faster conducted and implemented. Confidence could be also improved and I would actively be able to cope with a difficult situation. Therefore, my competency may be improved and my value may be increased.

B4. Who could be the key K-map maker/developer in your company?

A: A taskforce team should firstly be organised and professionals, who have a lot of construction/project management-related experiences and knowledge, should be taken part in the team. Human resource manager, KMr or CKO and CEO are necessary to join in the team. I think so because both of construction management system-related knowledge and construction work-related knowledge have to be involved and mapped in the K-map. This is my opinion.

B5. What can you consider as the major constraints of K-mapping in your company?

A: Firstly, in Korea, infrastructure for organising KM or K-map is weak. I mean in the underdeveloped KM area, fundamental and systematic theory and R&D are not performed by companies or researchers. I think standards of knowledge resources and artefacts must also be prerequisite and leadership of CEO or CKO is one of important constraints. Gaps between the management and practical workers are also one of the major constraints.

■ C. Interview questions about K-map components: Construction process, construction actor and Knowledge transfer technology.

C1. Considering construction project's components to systematically develop an appropriate K-map for construction knowledge transfer in projects, is it important?

A: Yes it is.

C11. Could you please explain why it is important for K-map?

A: Construction projects can not be performed and completed without managing construction processes. I mean a construction project is consisted of many processes and sub-processes. Therefore, process is important. Also construction actors may be a critical component of K-map because the construction processes are always executed and managed by the actors. So, the actors are very important. And in order to systematically and technically transfer and share construction-related knowledge in projects, technologies may be necessary because although the technologies are managed by people they can effectively support for transferring construction knowledge.

C12. In your opinion, what are the components of K-map?

A: Hum~~~. I am sorry I have no idea.

C13. Which benefits are you/your company likely to obtain, applying the components of K-map?

A: Firstly, objectives of project may be more easily achieved on the requirement of client. And as has been mentioned above, constructability and communications between members and sub-contractors in project would be improved. Also better quality knowledge may be created.

C14. What are the major constraints in your company, applying the components of K-map?

A: I think duplicate works can be performed because construction project is very complicated and related to many people and organisations and some technologies can not be used by people, such as civil servants, old construction actors and the other people. For example, some civil servants as the client do not like getting some information and data, using e-mail, phone and the others indirectly. I do not know why they do not like. However, this is practical and real. In brief, some people have negative mind and they do not like using and applying KM or K-map in projects. Effectiveness and efficiency of K-map for KM would thus be decreased by some people. That is it.

C2. Construction process

C21. Do you think construction processes are important to perform and manage construction projects?

A: Of course, it is very important.

C22. How significant are construction processes for construction projects?

A: As has been mentioned, it is very important.

C23. Do you think construction processes are appropriate and available as a component of K-map?

A: Of course. As has been mentioned, in order to be completed a construction project, many construction actors try to implement and manage construction processes which are related and interacted to each other. Therefore, a construction project can not be completed without performing construction project processes. Also I know PMIS of company have been developed, using and applying construction process as the component of system.

C24. In your experience or opinion, what types of construction processes are more important for projects?

A: In my experience, our company is performing and managing from feasibility stage to construction stage. Generally, pre-construction stage, I mean design stage, is recognised as the most important stage by people because in the stage, cost, time and quality can be effectively reduced and improved and knowledge related to design and design management is still shortage and is not managed enough yet. I can say success or failure of project is decided in pre-construction stage. I mean design management for effective construction work is necessary. That is it.

C25. In your opinion, why are the processes more important?

A: Because on the opportunity cost side, management of design stage is effective for cost reduction, time reduction and quality improvement. For example, if a design for project is clearly produced and effectively managed duplicate work or change order may not be generated. Project would thus be completed in limited project budget.

C26. What are the standards or considerations in order to decide?

A: Because of possibility of Cost reduction, time reduction, quality improvement.

C3. Construction actor

C31. When you were implementing your task in a construction project process have you experienced or felt needs of any knowledge including data and information in order to solve any problem or make any decision?

A: Of course, I have.

C32. How did you then gain the knowledge about it? Could you please describe about it?

A: Firstly, I have used my own data and information and after that, I have contacted my friends or colleagues to gain knowledge, using a mobile phone. Nowadays, I like using KMS of company and e-mail.

C32-1. Where did you get the knowledge? From the other staffs or company KMS?

A: I have gained from team members or colleagues in the section or department and sometimes KMS and the internet is effective to get comprehensive knowledge.

C32-2. What type of knowledge is…? Tacit or explicit knowledge?

A: Well~~~. Almost all are explicit knowledge.

C33. Do you think construction actors are important to perform and manage construction projects?

A: Of course I do.

C34. How significant are construction actors for construction projects?

A: Very much.

C35. Do you think construction actors are appropriate and available as a component of K-map?

A: Yes I do. However, I think scope of selecting and applying the actors is very important because in this company, too much knowledge is up-dated, but search engine and sorting system are terrible and ineffective. Knowledge is thus just stored and accumulated without sorting out and concept. That is a big problem. In my experience, I believe that selecting and applying too many actors and processes would be ineffective. Therefore, you need to simply and effectively regulate the scope of actors and processes for developing K-map.

C36. In your experience or opinion, what types of construction actors are more important for projects?

A: As has been mentioned above, some professionals, such as architect, PMr, CMr and QS are important because they are more deeply related to project performances and decision making about some major cases.

C37. In your opinion, why are the actors more important?

A: I have already mentioned above.

C38. What are the standards or considerations in order to decide?

A: Because they actually have core knowledge related to important decision in project.

C4. Construction knowledge transfer technology

C41. When you were implementing your task have you experienced or felt needs of any technology in order to efficiently transfer knowledge in construction projects?

A: Yes.

C42. What type of technology did you need or want to use for effectively knowledge transfer? Could you please describe about it?

A: Now I am using KMS, E-mail, Q&S system and the internet, but mobile phone would be effective in the future. Do you know that mobile technology is quickly improving? Mobile technology system would be applied to almost all of industries, installing camera, KMS, PMIS, voice recording system…etc. mobile phone may thus be one of the most important knowledge transfer technologies, but not yet.

Q43. What type of knowledge did you want to transfer? Is it tacit or explicit knowledge?

A: In my case, I was explicit knowledge.

C44. Has your company formally got any technology system or technologies to facilitate and enhance knowledge transfer and sharing between project members on construction sites?

A: KMS, expert system and Q&A system. That is all.

C45. What types of technologies are using for effectively knowledge transfer?

A: Expert system, KMS and Q&A system. That is all.

C45-1. Are you satisfied about the system?

A: I am satisfied around 60-70%.

C45-2. What type of knowledge is mainly transferred? Is it tacit or explicit knowledge?

A: In my case, I was explicit knowledge and formal.

C46. Do you think technology is important to transfer knowledge between members in construction projects?

A: I think yes. However, effectiveness should be considered.

C47. How significant is technology to transfer knowledge between members in construction projects?

A: I think very much because in a project or company, when knowledge is effectively shared knowledge can be recognised a asset of company.

C48. Do you think construction knowledge transfer technology is appropriate and available as a component of K-map?

A: Yes.

C49. In your experience or opinion, what types of technologies are more important and effective to transfer construction knowledge between members in projects?

A: Mobile phone would be good if mobile technology system is improved.

C50. In your opinion, why are the technologies more important and effective?

A: Accessibility, mobility and utility.

C51. What are the standards or considerations in order to decide?

A: Accessibility, mobility and utility…speed.

■ **D. In your experience and opinion, could you provide or propose any examples of unsuccessful K-map to transfer and share knowledge between members in company or project?**

A: I am sorry. I have no idea.

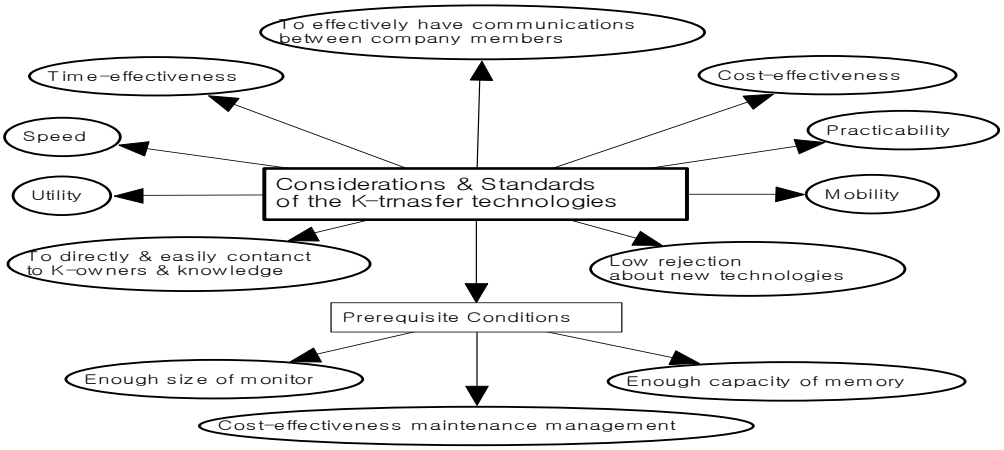
■ **E. Can you envisage or propose some components of K-map for construction knowledge project transfer in projects, such as construction**

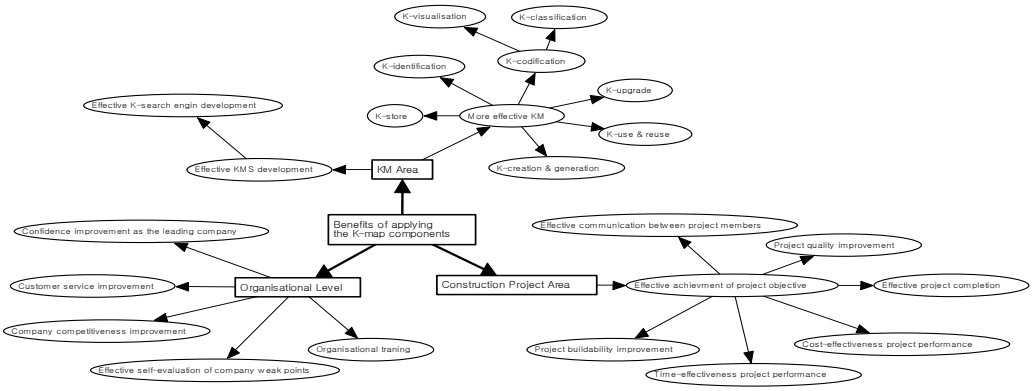
process, knowledge transfer technology, construction actor, construction technology, mobile computing system and construction equipment.

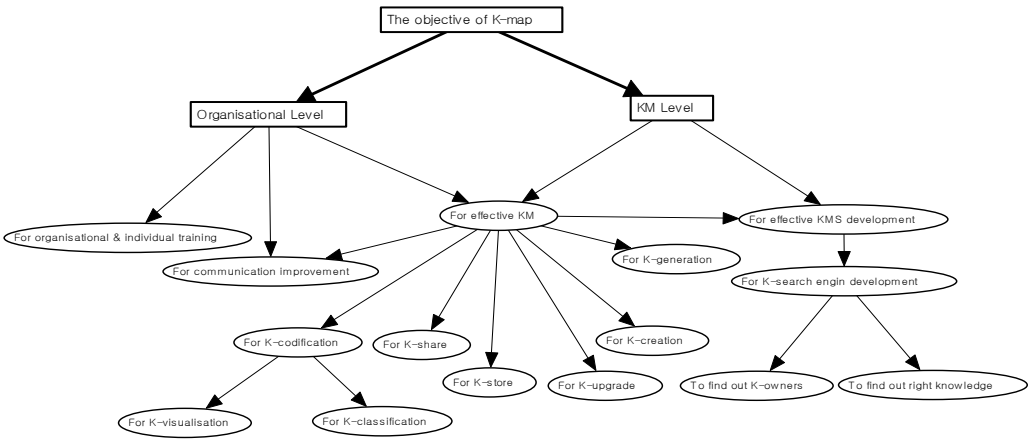
A: I think technology, process and actor. That is enough. Risk management and construction equipments and procedures…umum….. I think management systems, construction equipments and procedures are contained in the technology.

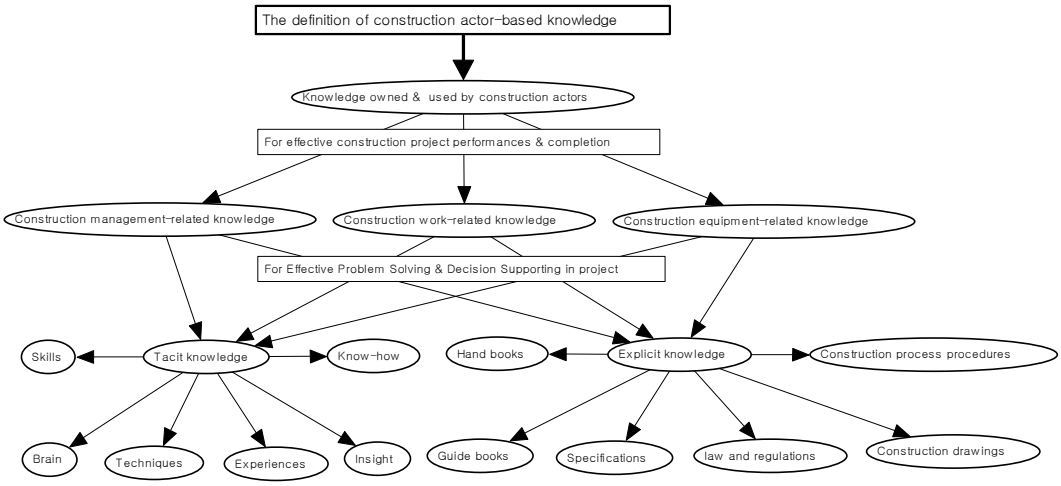
Thank you for spending your time and your attention

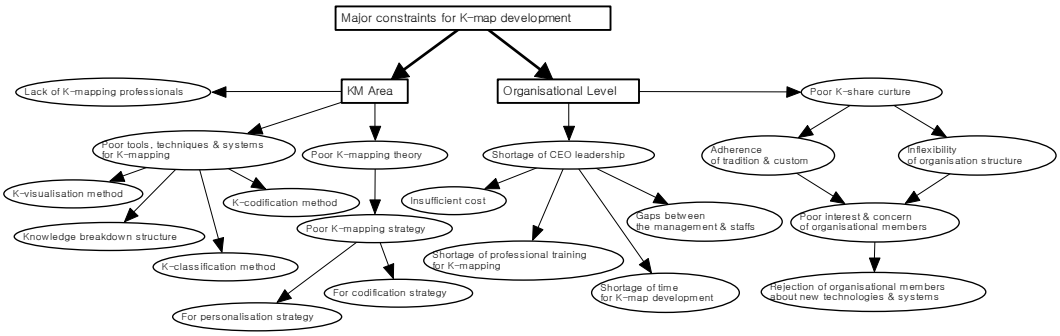
Appendix H: Sample cognitive maps made by NVivo

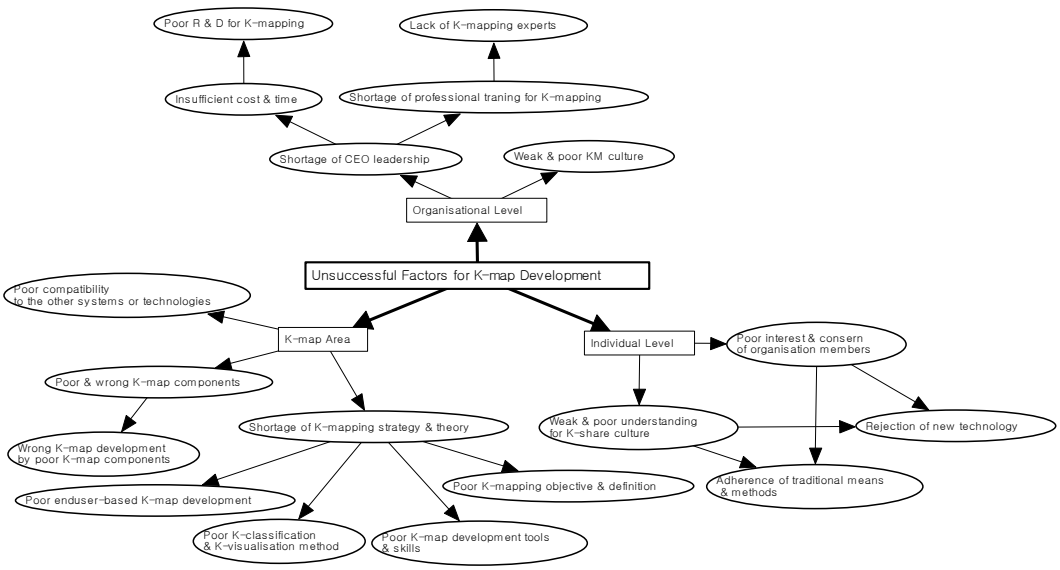







The definition of construction actor-based knowledge
Knowledge owned & used by construction actors
For effective construction project performances & completion
Construction management-related knowledge
Construction work-related knowledge
Construction equipment-related knowledge
For Effective Problem Solving & Decision Supporting in project
Skills
Tacit knowledge
Know-how
Hand books
Explicit knowledge
Construction process procedures
Brain
Techniques
Experiences
Insight
Guide books
Specifications
law and regulations
Construction drawings


Major constraints for K-map development
Lack of K-mapping professionals
KM Area
Organisational Level
Poor K-share curture
Poor tools, techniques & systems for K-mapping
Poor K-mapping theory
Shortage of CEO leadership
Adherence of tradition & custom
Inflexibility of organisation structure
K-visualisation method
K-codification method
Insufficient cost
Gaps between the management & staffs
Poor interest & concern of organisational members
Knowledge breakdown structure
Poor K-mapping strategy
Shortage of professional training for K-mapping
K-classification method
For codification strategy
Shortage of time for K-map development
Rejection of organisational members about new technologies & systems
For personalisation strategy


Poor R & D for K-mapping
Lack of K-mapping experts
Insufficient cost & time
Shortage of professional traning for K-mapping
Shortage of CEO leadership
Weak & poor KM culture
Organisational Level
Unsuccessful Factors for K-map Development
Poor compatibility to the other systems or technologies
K-map Area
Individual Level
Poor interest & consern of organisation members
Poor & wrong K-map components
Shortage of K-mapping strategy & theory
Weak & poor understanding for K-share culture
Rejection of new technology
Wrong K-map development by poor K-map components
Poor K-mapping objective & definition
Adherence of traditional means & methods
Poor enduser-based K-map development
Poor K-classification & K-visualisation method
Poor K-map development tools & skills

Appendix I: A set of presentation paper for effective interview performance

The utility and application of knowledge maps in construction projects

Gang Yun & Martin Sexton

Research Institute for the Built and Human Environment
University of Salford, United Kingdom

1

Research background

KM aims to effectively manage knowledge in order to better achieve the objectives of project and the requirements of client.

In the underdeveloped area of KM, K-mapping has been recognised as a means of structuring knowledge in an appropriate way to support construction activity.

2

Research problems

Poor use of knowledge within and across projects and actors to support project-based work from different actor perspectives

3

Research focus

KM has been recognised as an innovative process in order to leverage business context and project activities throughout efficiently managing knowledge including data and information.

In particular, K-map which is one of the components of KM, and a prerequisite in order to effectively organise the KM relevant to a construction project

4

What is K-map?

K-map is a component and the cornerstone of KM, since it functions as a indispensable component to visualize knowledge resources and to identify relationships among knowledge artefacts

Tiwana (2002); Kang *et al.* (2003)

5

What are the benefits?

- to better generate knowledge and ideas
- to effectively design and visualise complex structures: long text, hypermedia, large web sites
- to communicate complex knowledge and ideas
- to aid individual and organisational learning by explicitly integrating new and old knowledge
- to easily access to relevant knowledge

Grey, 1999; Meso and Smith, 2000; White, 2002

6

Why do we need K-map in project?

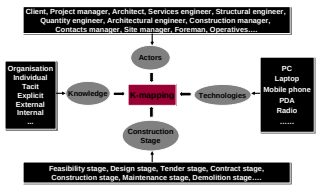
❑ The characteristics of construction project

- has different construction conditions on site : site, time, cost, scope, people…
- is a very complex process-based project
- is always performed and accomplished by people : people is at the heart of project activities
- is related to many technologies, management systems, practitioners, knowledge, processes..

Yisa *et al.*, 1996; Walker, 2002; Griffith and Watson, 2004

7

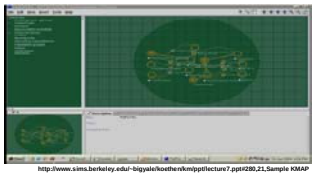
How can the K-map be developed in construction?



8

A example of K-map

A visual knowledge map as an aid to online information retrieval



http://www.sims.berkeley.edu/~bigyale/koethen/km/ppt/lecture7.ppt#280,21,Sample KMAP

9

A example of K-map

A Concept Map about Plants with Associated Resources

http://www.ihmc.us/users/acanas/Publications/CMapsVSWebPagesExp1/CMapsVSWebPagesExp1.htm

10

Conclusion

- The components of K-mapping should be explored prior to codifying the K-map in order to effectively develop the KM relevant to a construction project.
- The components should be considered in order to develop better KM for construction projects.
- In this paper, a K-mapping Concept Model has been suggested, and it will be employed to investigate the utility and application of K-maps, and supported to systematically develop the K-map relevant to a construction project.

11

Future directions

- Research methodology
  - Case study design
  - Sampling strategy
  - Data collection
  - Data analysis

12

Thank for your attention

13